Middlefork White River and Blackfoot Creek Juvenile Bull Trout and Fish Habitat Monitoring Program

Monitor and Protect Wigwam River Bull Trout for Koocanusa Reservoir

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BONNEVILLE POWER ADMINISTRATION

Middlefork White River and Blackfoot Creek Juvenile Bull Trout and Fish Habitat Monitoring Program: 2003 Data Report

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Executive Summary

The Middlefork White River and Blackfoot Creek juvenile bull trout (*Salvelinus confluentus*) and fish habitat-monitoring program is a co-operative initiative of the British Columbia Ministry of Water, Land, and Air Protection and Bonneville Power Administration. This project was commissioned in planning for fish habitat protection and forest development within the White River watershed and was intended to expand upon similar studies within the Wigwam River (2000-2002) and Skookumchuck Creek (2002-2004). The broad intent is to develop a better understanding of juvenile bull trout and Westslope cutthroat trout recruitment and the ongoing hydrologic and morphologic processes, especially as they relate to spawning and rearing habitat quality. The 2003 project year represents the first year of a three-year bull trout-monitoring program with current studies focused on collecting baseline information. This report provides a summary of results obtained to date.

Bull trout represented 99.5% of the catch. Fry dominated the catch because site selection was biased towards electrofishing sample sites which favored high bull trout fry capture success. Slimy sculpin were the only other species enumerated. Westslope cutthroat trout were observed and angled from deep pool habitat.

The mean density of all juvenile bull trout was estimated to be 16.6 fish/100m^2. These densities are comparable to the upper Wigwam River bull trout spawning reaches, and densities of this magnitude, are some of the highest reported within the species distribution range. Furthermore, Site 1 (Middlefork) densities were the highest densities reported in the five years of sampling for this program. Based on these comparisons, the upper Middlefork White River and Blackfoot Creek should be considered critical spawning and rearing habitat for the upper Kootenay River population of bull trout.

Trends in abundance appeared to be related to proximity to spawning areas, bed material size, and water depth. Cobbles and gravels that provide prime spawning and juvenile rearing habitat dominate the upper Middlefork and Blackfoot Creek. The exception was Site 2, where the gravel and sand dominated substrate were clearly not suitable for fry and juvenile rearing. Given that a large number of redds are annually enumerated within this site, a downstream displacement of fry to more suitable benthic cover (cobbles) would explain the very high densities observed at Site 1.

The range of morphological stream types for the Middlefork White River encompasses the stable and resilient spectrum (C4(1) and C4). The index sites can be generalized as a slightly

entrenched, meandering, riffle-pool, and gravel-cobble dominated channel with a well-developed floodplain. High large woody debris (LWD) frequency, high pool frequency and high channel sinuosity, provide exceptionally high habitat complexity with high quality bull trout and Westslope cutthroat trout spawning and rearing habitat, for all life stages. In large part, habitat diversity and stream stability can be attributed to the extensive, intact, floodplain that was dominated by old-growth forest and relic channels. Aggressive salvage logging is presently underway within the burnt area immediately adjacent and upstream of this site. Caution is advised, as the cumulative impacts of wildfire and salvage logging are a concern for this important bull trout spawning and rearing area.

Blackfoot Creek, in contrast, was considered severely degraded and unstable. The headwaters of this tributary were burned by wildfire and some historic salvage logging has occurred. The index site was located at the downstream limit of the wildfire, the west streambank was salvage logged to the streambank, and large inputs of coarse sediment were evident. It was hypothesized that the Blackfoot Creek index site was at an early stage of recovery, where the channel dimension, pattern and profile were undergoing a successional evolution from an F3 stream type to a C3 stream type. Infilled and abandoned meanders were clearly visible, as were the chute cutoffs and over-steepened and eroding stream banks. However, there remains a high probability of further degradation and adverse fish habitat impacts, due to future flood events, given the instability of the stream channel and the extreme erosion potential of the over-steepened and eroding stream banks.

Despite the degraded nature of the Blackfoot Creek index site, it still maintains bull trout spawning habitat and high densities of rearing juveniles. This was attributed to two dominant features preferred by spawning and rearing bull trout. First, the high densities of juvenile bull trout are due to the very coarse “bony” substrate of large cobbles and small boulders. Bull trout juveniles are benthic orientated and the streambed of Blackfoot Creek provides abundant, high quality interstitial cover habitat of the type preferred by juvenile bull trout. Secondly, the narrow alluvial floodplain that is bounded by steep mountain slopes has contributed to a predominance of sub-surface flow that reaches the mainstem as groundwater. The provision of suitably sized bed materials in a low gradient, low water velocity location with associated groundwater have been identified as repeating patterns of preferred bull trout spawning habitat.

Acknowledgements

The Middlefork White River and Blackfoot Creek juvenile bull trout and fish habitat-monitoring program is a trans-boundary initiative implemented by the British Columbia Ministry of Water, Land, and Air Protection (MWLAP), in cooperation with Bonneville Power Administration (BPA). Funding was provided by BPA under the umbrella project "Monitor and Protect Bull Trout for Koocanusa Reservoir"; BPA project Number 2000-004-00. The contribution and on-going monitoring results provided by Herb Tepper, Bill Westover and Kevin Heidt (MWLAP) are acknowledged and greatly appreciated. Kerry Morris, and Angela Prince of Westslope Fisheries contributed to data collection and reporting.

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1 Introduction

This report summarizes the first year of a three year juvenile bull trout (*Salvelinus confluentus*) and fish habitat-monitoring program for the Middlefork White River and Blackfoot Creek. The White River is a regionally significant sportfish stream located in southeastern British Columbia that supports healthy populations of both bull trout and Westslope cutthroat trout (Figure 1). Biotelemetry investigations have identified the Middlefork White River and Blackfoot Creek as important bull trout-spawning tributaries within the White River (B. Westover, MWLAP, Cranbrook, B.C., *pers. comm*.). The White River also supports Westslope cutthroat trout (*Oncorhynchus clarki lewisi*). The Middlefork White River and Blackfoot Creek juvenile bull trout and fish habitat-monitoring program is a trans-boundary initiative implemented by the British Columbia Ministry of Water, Land, and Air Protection (MWLAP), in cooperation with Bonneville Power Administration (BPA).

Bull trout populations have declined in many areas of their range within the Pacific Northwest including British Columbia. Bull trout were blue listed as vulnerable in British Columbia by the B.C. Conservation Data Center (Cannings 1993), and although there are many healthy populations of bull trout in the East Kootenay, they remain a species of special concern. Bull trout in the United States portion of the Columbia River were listed as threatened in 1998 under the Endangered Species Act by the U.S. Fish and Wildlife Service. The upper Kootenay River watershed (above Libby Dam) is within the Kootenai sub-basin of the Mountain Columbia Province, one of the eleven Eco-provinces that make up the Columbia River Basin, and has become a primary focus of research for bull trout in both Canada and the United States.

MWLAP applied for and received funding from BPA to assess and monitor the status of wild, native stocks of bull trout in tributaries to Lake Koocanusa (Libby Reservoir) and the upper Kootenay River. The Middlefork White River and Blackfoot Creek juvenile bull trout and fish habitat-monitoring program is one of many that were undertaken to "Monitor and Protect Bull Trout for Koocanusa Reservoir" (BPA Project Number 2000-04-00). These include comparative juvenile bull trout and fish habitat studies in the Wigwam River (Cope 2003b) and Skookumchuck Creek (Cope 2004), adult enumeration projects on the Wigwam River (Baxter and Westover 2000), Skookumchuck Creek (Baxter and Baxter 2002), and the White River (Cope and Morris 2004), as well as an upper Kootenay River basin-wide radio telemetry project (B. Westover, MWLAP, Cranbrook, B.C., *pers. comm*.).

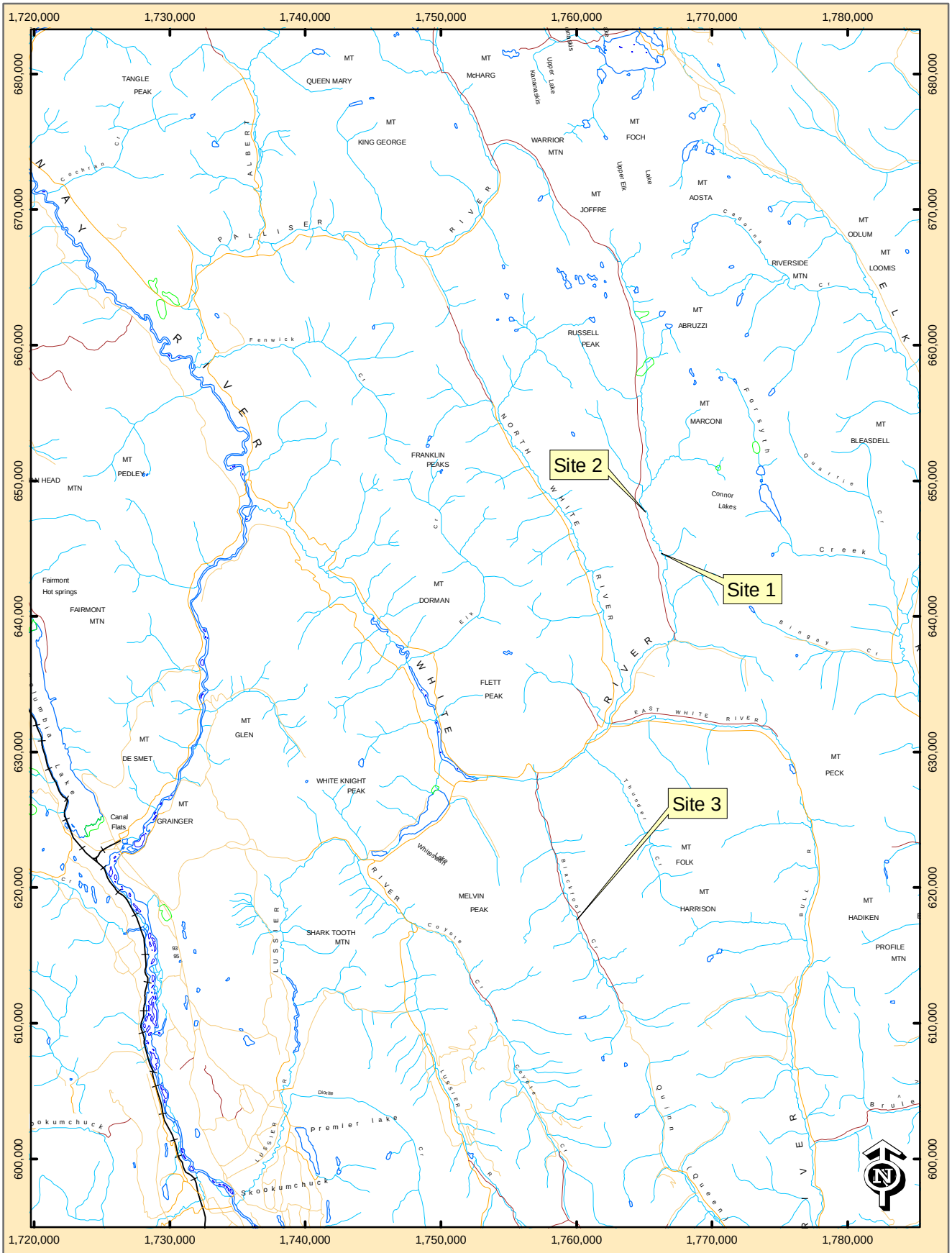


Figure 1 : Overview Map of the White River and Blackfoot Creek

Date:January 2004
Scale: 1 : 400 000
Drawing: WhiteRiverOverview.mxd
Projection: BC Albers - Nad 83 Datum

0 5 10 15 20
Kilometers

WESTSLOPE FISHERIES

1.1 Objectives

At each permanent index site (n=3), over three consecutive years, juvenile fish densities, stream habitat conditions, and detailed geomorphic surveys will be documented. The objective of this project is to develop a better understanding of inter-annual variation in juvenile bull trout and Westslope cutthroat trout recruitment and the ongoing hydrologic and morphologic processes in the Middlefork White River and Blackfoot Creek, especially as they relate to spawning and rearing habitat quality. Data is collected in a compatible manner for companion studies of sympatric fish populations within the Wigwam River and Skookumchuck Creek. The data for these watersheds will contribute to the development of a long-term monitoring and stock assessment program for the upper Kootenay River bull trout and Westslope cutthroat trout populations that should ensure potential impacts from increased development and angling pressure are minimized.

1.2 Study Area

The White River originates in the Height of the Rockies Wilderness Area (HOTR), located along the western edge of the continental divide between the Park and Front Ranges of the southern Rocky Mountains in southeastern British Columbia. The upper basin of the White River is divided into three large forks. The North Fork White River and the Middlefork White River flow south approximately 40 km until they join the East Fork of the White River (Figure 1). At this junction, the White River flows west for approximately 10 km. At Whiteswan Provincial Park the river turns north for its final 34 km until it empties into the upper Kootenay River, approximately 30 km north of the village of Canal Flats (Figure 1). The headwaters of the White River drainage originate from glacier fed alpine lakes at an elevation of approximately 2,440 m and declines to 910 m.

Provincial management objectives for the White River are protection of bull trout and Westslope cutthroat trout spawning areas and angler use of wild fish. Bull trout and Westslope cutthroat trout are the primary management species and are highly sought after by local, regional and international anglers. A local commercial guiding industry caters to recreational fishermen targeting these fish.

The White River is characterized by long, narrow and forested valleys running through the rugged Rocky Mountains. Elevated layers of limestone dominate the geology. Three biogeoclimatic zones dominate the valleys. Montane Spruce at lower elevations, Engelmann Spruce and Sub alpine fir at middle elevations are the most common and alpine tundra at higher elevations (above approximately 2300 m).

In 1936, a forest fire burned much of the HOTR. In 2003, a wildfire again burned much of the HOTR and the upper Middlefork White River. Currently, aggressive salvage logging is being undertaken within the upper reaches of the Middlefork White River watershed below the HOTR. Prior to 2003, approximately 29 km^2 or 9.35% of the total watershed (310 km^2) has been harvested (Hundal 2001). Historic logging within the Middlefork White River drainage concentrated on the floodplain and low elevation stands, and as a result, 6% of the fish bearing stream bank has been logged or burned (Hundal 2001).

The White River has a total watershed area of 987 km^2. The flow regime is comparable to most interior streams with high annual run-off reaching it's peak in June or July and expected low flows in late fall and winter (Figure 2).

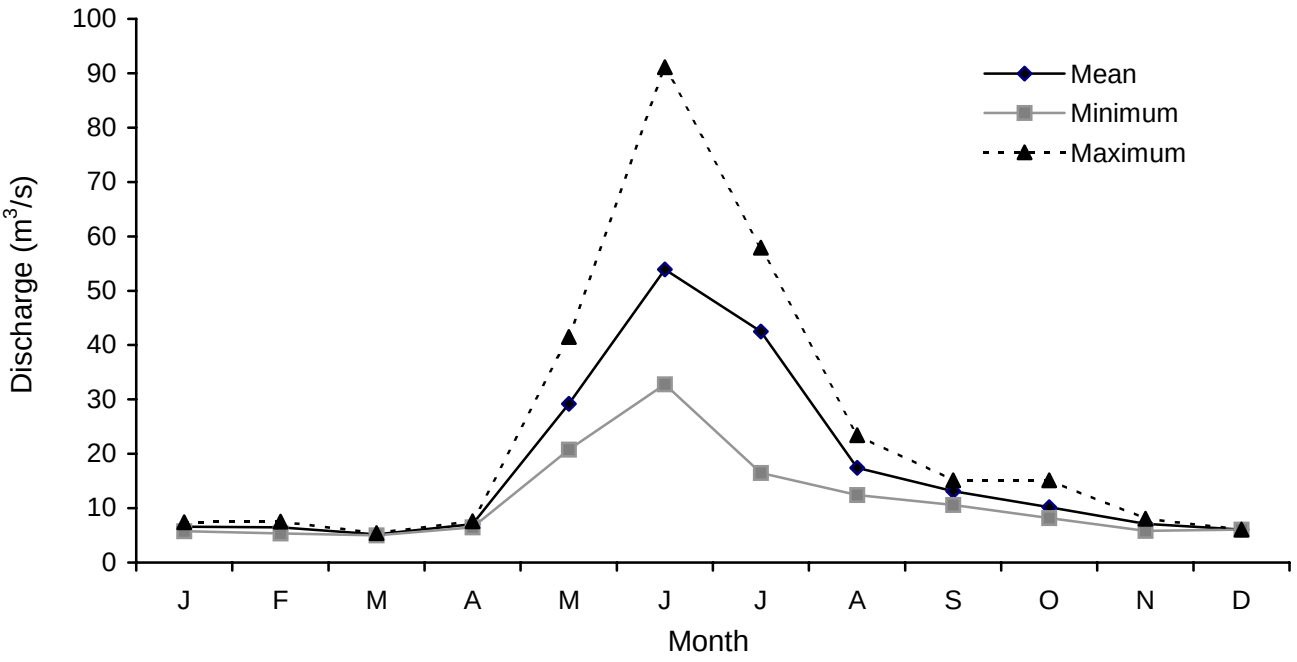


Figure 2. Mean, minimum, and maximum monthly discharge for the White River near Canal Flats, 1940-1948 (WSC Stn No. 08NF003).

2 Methods

In July 2003, two permanent sampling sites were established in the Middlefork White River, and one permanent sampling site was established in Blackfoot Creek. The UTM coordinates for the upstream and downstream limits of the longitudinal survey, the pool and riffle cross-sectional survey habitat units and the electrofishing sample sites were overlain on the digital NAD 83 Forest Cover TRIM Sheet and plotted (Appendix A, 1:40,000 TRIM map).

Sampling sites were a minimum of 20 channel widths in length or a distance equal to two stream meander wavelengths. At each site the following reference points were permanently established, geo-referenced (UTM) and marked with a combination of metal tree tag, tree blaze, fluorescent tree paint, and flagging tape:

- Upstream and downstream elevation benchmarks. Elevation benchmarks were represented by a lag bolt imbedded in the base of a large, stable, riparian tree,
- Upstream and downstream limits of the longitudinal survey,
- Riffle and pool cross-sectional benchmarks (lag bolt imbedded in the base of a riparian tree) and bank “pins” representing the start and finish reference points, and
- Electrofishing habitat units.

The following methods outline the specific assessments completed at each of the three permanently established sites.

2.1 Juvenile Enumeration

Estimates of juvenile fish density (number of fish/100 m^2) were determined using closed, maximum-likelihood removal estimates (Riley and Fausch 1992). For each site, three habitat units (riffle, pool and run) were individually sampled for fish densities over 100 lineal meters and/or 500 m^2. This methodology allows for habitat unit comparisons as well as reach comparisons through pooling of habitat units to obtain a mean. A Smith-Root Mark 12POW backpack electroshocker was used for successive depletions within each closed sample unit. Although bull trout are the main focus of this project, densities of all fish captured were reported.

Catch results from individual habitat units were summed, by pass, at each representative reach location. These results were then used to estimate the number of fry (0^+ age class)

and juveniles (1^+ and 2^+ age classes) within the composite enclosure area. Population estimates were calculated using the "Microfish" software package (Van Deventer and Platts 1990). Population estimates and their 95% confidence interval were then reported as a standard numerical density (number fish/100 m^2) for each site.

During electrofishing surveys, stream discharge was estimated at each location using a Price 1210AA velocity meter and wading rod calibrated bi-annually by the National Calibration Service of the National Water research Institute. All methods meet national and provincial standards and have demonstrated precision levels of less than +/- 5% (Prince and Morris 2003).

2.2 Fish Habitat Assessment

A standard suite of habitat parameters were collected using the Resource Inventory Committee (RIC) approved Fish Habitat Assessment Procedures (FHAP), Level 1, Form 4 - Habitat Survey Data Form (Johnston and Slaney 1996). The level 1 FHAP is a purposive field survey of current habitat conditions for the target species in select reaches. This form has been developed for interpretation of habitat sensitivity and capability for fish production and includes prominent physical features such as pool and riffle ratios, residual pool depths, channel stability, flood indicators, cover components, abundance of large woody debris (LWD), and riparian vegetation.

Following methods described in Rosgen (1996) the following measurement of channel profile, pattern and dimension were also completed:

- A longitudinal profile (minimum of 20 channel widths in length or a distance equal to two stream meander wavelengths) of the stream bed following the thalweg of the stream channel including measurement of water surface (slope) and bankfull elevations;
- Stream cross-sections on both a riffle and pool segment (stream bed, water surface, thalweg and bankfull elevations);
- Channel pattern (width flood prone area, sinuosity, belt width, meander length and radius of curvature), and
- Modified Wolman pebble count (reach and active channel at a riffle).

At 10m intervals, following the thalweg of the stream channel, the elevation of the streambed and the water surface was surveyed over the length of the study area. All

stream and habitat unit gradients were calculated from differences in water surface elevation. Cross sectional profiles were surveyed at 1 m intervals and extended 5m beyond the bankfull width. The elevation of the bankfull channel was also noted at each cross section location and periodically throughout the longitudinal survey. Geomorphic surveys were completed using an auto level (Topcon AT-G7 Auto Level) and standard differential hydrometric survey techniques (Anon. 1998). A differential loop was used to accurately determine benchmark elevations, express error terms and ensure quality control.

Channel bed material characterization employed the modified Wolman method outlined in Rosgen (1996). Briefly, this procedure uses a stratified, systematic sampling method based on the frequency of riffle/pools and step/pools occurring within a channel reach that is approximately 20-30 bankfull channel widths in length (or two meander wavelengths). The modified method adjusts the material sampling locations so that various bed features are sampled on a proportional basis along a given stream reach. In total, 10 transects are established and ten substrate particles are selected at systematic intervals across the bankfull channel width, for a total sample size of 100. To avoid potential bias, the actual particle was selected on the first blind touch, rather than visually selected. The intermediate axis of the particle was measured such that the particle size selected would be retained or pass a standard sieve of fixed opening. The composite particle distribution was used to represent the reach. A second modified Wolman pebble count was completed within the active channel (*i.e*. within the wetted width), at the representative riffle cross-section, to calculate D_{84}. The D_{84} estimate was then used as a roughness coefficient in velocity calculations (Appendix G).

3 Results

The sampling schedule for the 2002 fish and fish habitat-monitoring program is summarized in Table 1.

Table 1. Schedule of program field components for the Middlefork White River and Blackfoot Creek bull trout and fish habitat monitoring program, 2003.

Program Component	Date
Establishment of Permanent Sample Sites	July 25
Juvenile Fish Density Sampling	August 8-10
Level 1 FHAP Form 4 Measurements and Channel Surveys	September 18 – October 1

3.1 Juvenile Fish Sampling

3.1.1 Species Composition and Distribution

In total, 181 bull trout fry and juveniles were captured within 9 habitat units that were sampled across three index sites (Appendix B). Table 2 summarizes sample effort and total catch across sites. All captures were bull trout fry or juveniles with the exception of one slimy sculpin captured in Site 1.

Table 2. Total effort (seconds of backpack electrofishing and area) and catch (no. of fry and juvenile bull trout combined) for the three Middlefork White River and Blackfoot Creek bull trout index sites. Note that the non-salmonid catch has been included in the totals denoted by brackets.

Site	Electrofishing Effort (seconds)	Sample Area (m^2)	Total Catch (No. Fish)
1	8,981	394	106(107)
2	6,729	413	6
3	8,944	518	69
Total	24,654	1,325	181(182)

In total, 182 fish were captured within the index sites (Table 3). A total of 154 bull trout (BT) fry representing 84.6% of the catch, and 27 bull trout juveniles representing 14.8% of the catch, were captured during the sample period 8 – 10 August 2003. Bull trout were the dominant salmonid species encountered, representing 99.5% of the total catch. Bull trout fry were the target species and life stage and as such, their predominance in the catch composition reflects bias associated with site selection for this capture target. Additional non-salmonid catch was represented by one slimy sculpin (CCG;Table 3). Westslope cutthroat trout adults were observed and angled from deep pool habitat however, fry and juveniles were absent from the electroshocking catch.

Table 3. Catch composition for the Middlefork White River and Blackfoot Creek juvenile bull trout monitoring program, 2003.

Site	BT Fry	BT Juv.	CCG	Total
1	100	6	1	107
2	6	0	0	6
3	48	21	0	69
Totals	154	27	1	182

3.1.2 Bull Trout

Bull trout fry (n=154) were captured in all sample sites and bull trout juveniles (n=27) were captured exclusively in Sites 1 and 3. In total, 181 bull trout were sampled for life history information (Table 4). All captured bull trout were fry or juveniles and ranged in fork length from 33 mm to 160 mm and the modal class, in 10 mm intervals, was 40-49 mm (Figure 3). This size class represents the young-of-the-year cohort (fry, 0^+). The relative proportions of age classes comprising the total bull trout catch were 84.6% fry (0^+) and 14.8% and 0.6% juveniles ($1^+$and 2^+, respectively). Mean fork lengths of each age class (estimate) were 47.3 mm (0^+), 101.6 mm (1^+) and one juvenile 160 mm (2^+) was captured. The corresponding mean weights for bull trout age classes were 1.2, 12.6 and 46.7 g respectively (Table 4). The growth rate of juvenile bull trout in the Middlefork White River and Blackfoot Creek study area was described by the equation:

$$Log_{10}Weight = -5.026 + 3.029\ Log_{10}Length$$ (Figure 4).

Table 4. Summary of fork length and weight data collected from bull trout fry and juveniles captured within the Middlefork White River and Blackfoot Creek, August 2003.

	Age-Group		
	0^+	1^+	2^+
Mean Fork Length (mm)	47.3	101.6	160
Standard Error	0.4	3.5	N/a
Range	33-63	79-139	N/a
N	153	27	1
Mean Weight (g)	1.16	12.57	46.7
Standard Error	0.03	1.46	N/a
Range	0.4-2.7	5.5-29.9	N/a
N	153	27	1

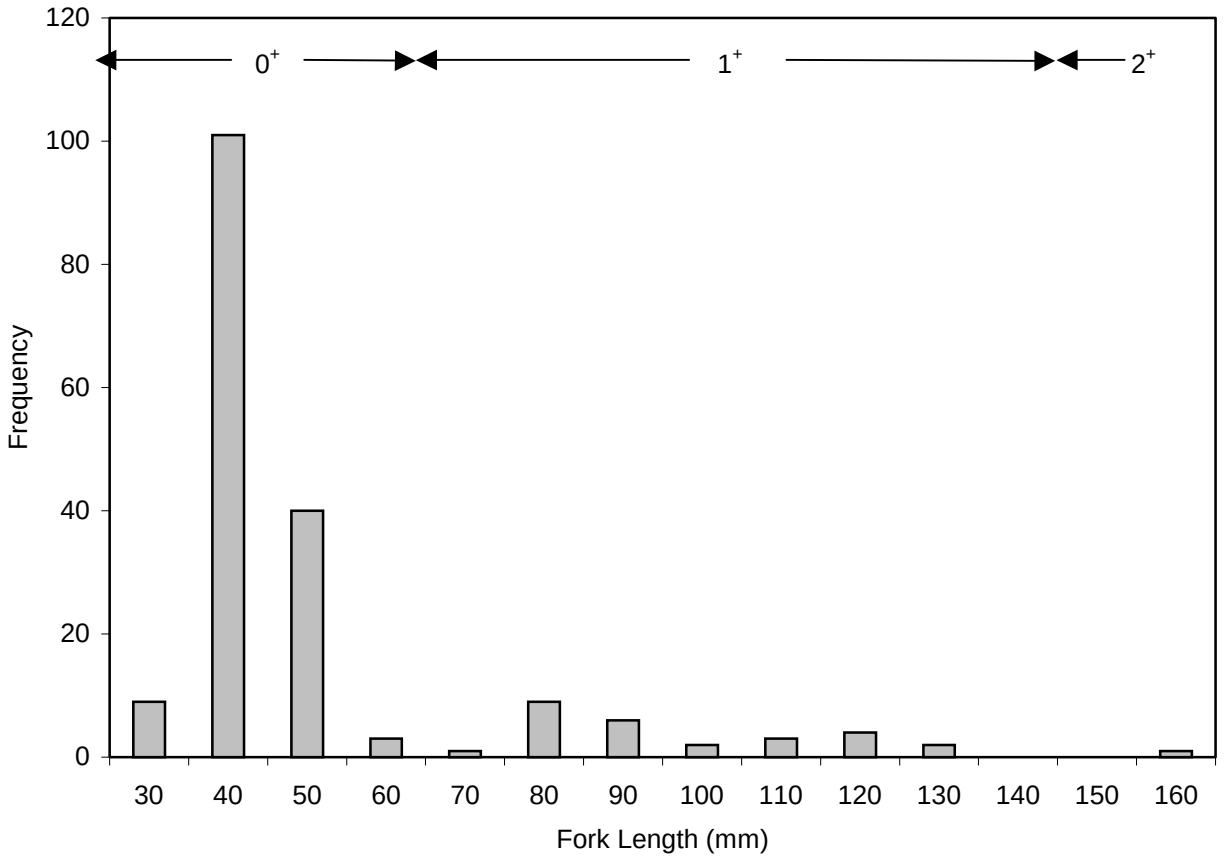


Figure 3. Length frequency distribution and estimated age cohorts for Middlefork White River and Blackfoot Creek juvenile bull trout, August 2003.

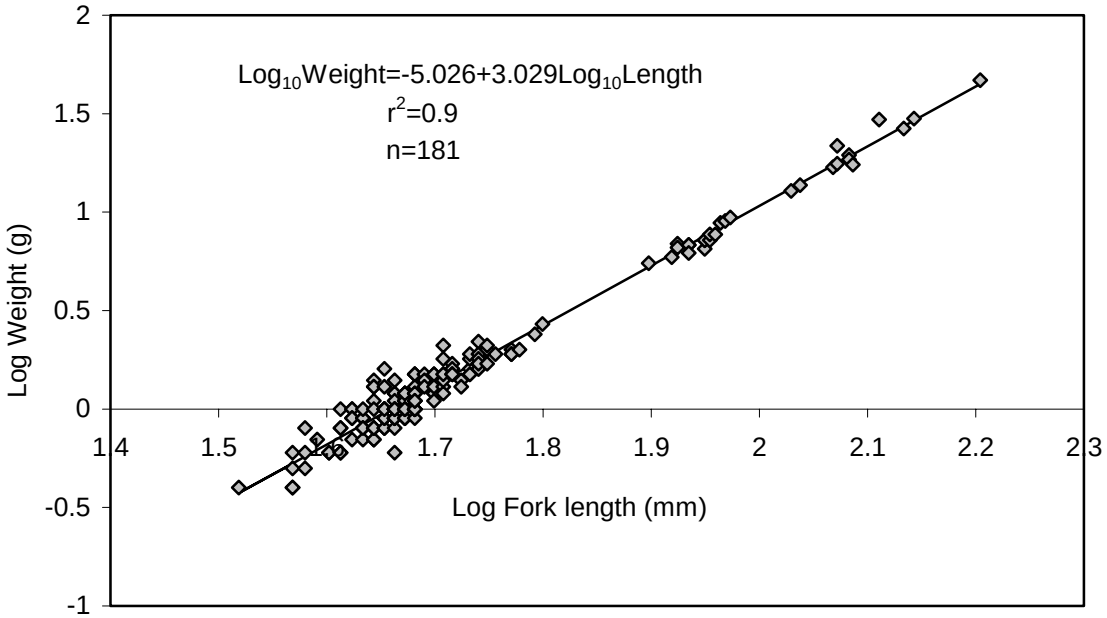


Figure 4. Length-weight regression for bull trout captured within the Middlefork White River and Blackfoot Creek, August 2003.

The overall mean density of fry and juvenile bull trout combined was estimated to be 16.6 fish/100 m^2 (95% confidence interval 14.2 – 19.0 fish/100 m^2). The overall mean density of fry was estimated to be 14.0 fish/100 m^2 (95% confidence interval 11.9 – 16.2 fish/100 m^2), and the overall mean density of juvenile bull trout was estimated to be 2.4 fish/100 m^2 (95% confidence interval 2.1 – 3.1 fish/100 m^2). The mean density of fry and juvenile bull trout within individual index sites ranged from 1.5 to 36.3 fish/100 m^2 (Table 5). Densities were significantly higher in Site 1 of the Middlefork White River and trends in fry abundance were related to substrate size. The observed distribution was somewhat unexpected, as site 2 contains at least as many redds as Site 1.

Table 5. Mean density estimates (+/- 95% confidence interval) for fry and juvenile bull trout combined, at three permanent sample sites, within the Middlefork White River and Blackfoot Creek.

Site	Density (+/- 95% C.I.) fish/100 m^2
Middlefork White River – Site 1	36.3 (26.9 – 46.5)
Middlefork White River Site 2	1.5 (1.5 – 1.7)
Blackfoot Creek – Site 3	14.7 (13.3 - 16.6)
Overall Mean	16.6 (14.2 – 19.0)

3.2 Physical Habitat Monitoring

3.2.1 Water Temperature and Discharge

Discharge estimates within the index sites, during habitat sampling, ranged from 8.5 to 0.7 m^3/s (Table 6). Bankfull discharge was estimated from flood frequency analysis conducted using maximum instantaneous discharges recorded at the White River Water Survey of Canada (WSC) Hydrometric Station (08NF003) near Canal Flats (Figure 5). Due to the limited number of observations (n=7), and the dated nature of the source data (1941-47), this analysis was supplemented with a hydrologic analysis of the Palliser River (08NF006). The Palliser River is immediately north of the White River, also flows in a westerly direction into the Kootenay River, has a drainage area of 653 km^2, and was gauged from 1973 to 1994 (n=22; Figure 5). The bankfull discharge estimates for the study area above the WSC gauges were transferred using the following equation:

Site Discharge = WSC Gauge Discharge * (Area Above Site/Area Above Gauge)$^{0.75}$

Table 7 illustrates the bounds of the expected bankfull discharge (*i.e*. between 1 and 2 year flood frequency) for the permanent index sites. The actual bankfull discharge was probably somewhere between the two estimates generated from the White and Palliser Rivers. In 1999, just upstream of Klookuh Creek, Nanrich (2000 *from* Hundal 2001) collected Middlefork stream flow data. The drainage area at this site was approximately 228 km^2 and the maximum instantaneous discharge was 36 m^3/s. That year was a high runoff year as snowpacks were 120% of normal (Hundal 2001). Additionally, the unit discharge estimate ($m^3/s/km^2$) appears to increase for each successive watershed in a northward direction (*i.e*. White<Palliser<Albert; Hundal 2001). An approximate bankfull estimate of 27 m^3/s at Site 1

Table 6. Summary of water temperature, mean velocity, and discharge measurements for the index sites during the 2003 sample period.

Site	Date	Water Temp. (^{o}C)	Mean Velocity (m/s)	Discharge (m^3/s)
Middlefork Site 1	10 August	8.7	0.86	8.52
Middlefork Site 2	9 August	6.2	0.62	7.14
Blackfoot Creek Site 3	8 August	11.2	0.41	0.71

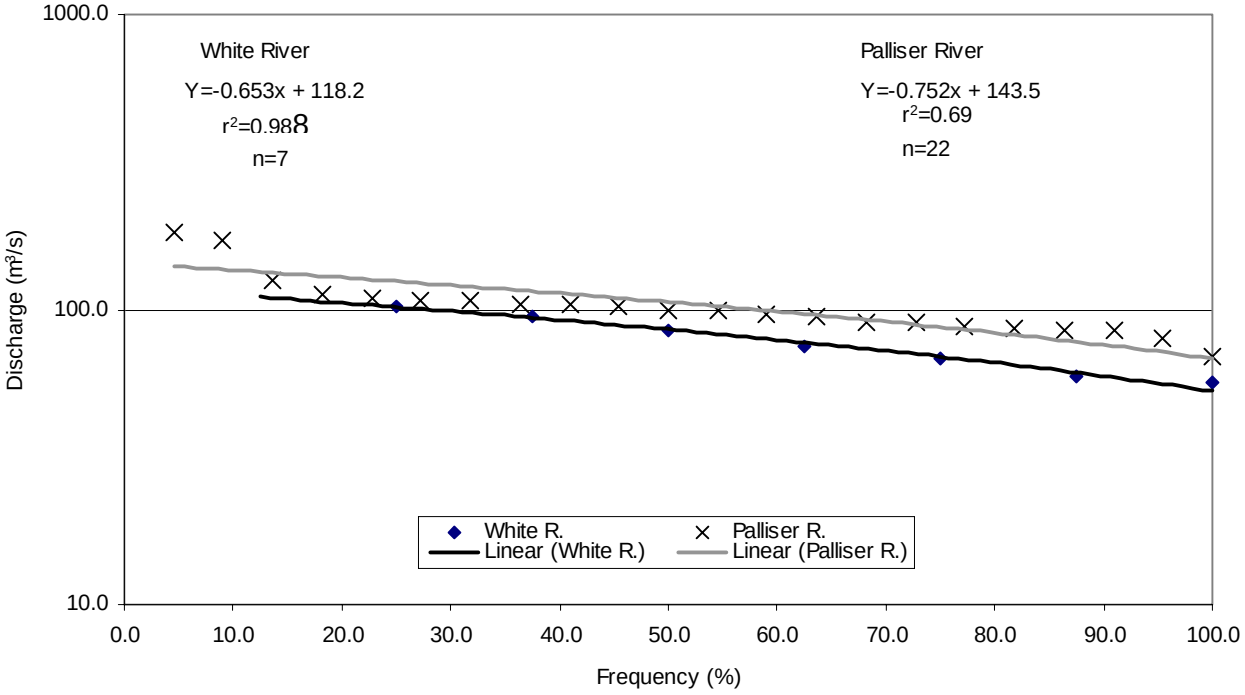


Figure 5. Flood-frequency analysis using maximum instantaneous discharge for the White and Palliser Rivers.

Table 7. Discharge estimates for the range of potential bankfull discharges based on the historical maximum instantaneous discharge for the White and Palliser Rivers.

Flood - Frequency	Discharge Estimate (m^3/s)							
	Gauge Site		Site 1(202 km^2)		Site 2(192 km^2)		Site 3[a](85 km^2)	
	White	Palliser	White	Palliser	White	Palliser	White	Palliser
1:2	85.6	105.9	26.1	43.9	25.1	42.3	13.6	22.9
1:1.5	74.7	93.3	22.7	38.7	21.9	37.3	11.9	20.2
1:1	52.9	68.3	16.1	28.3	15.5	27.3	8.4	14.8

a – Note that there was no historical discharge record for Blackfoot Creek and the area based extrapolation using the White and Palliser Rivers data was applied.

was proposed, based on a bankfull return frequency of 1 in 1.5 years.

Spot temperatures during electrofishing were indicative of glacial headwaters and/or cold perennial springs preferred by bull trout (<12 ^{o}C). Peak daily water temperatures (spot temperatures taken at approximately 16:00 hrs) were approximately 6 to 9 ^{o}C in the Middlefork sites and 11 ^{o}C in the Blackfoot Creek site.

3.1.2 Substrate Pebble Counts

Mean size of sediment particles less than six percent categories (*i.e.* D_{16}, D_{35}, D_{50}, D_{65}, D_{84}, D_{95}) are provided for the 2003 pebble counts. Both the active channel in a riffle and the reach composite within the bankfull channel are presented for the three index sites (Table 8). The index sites differed substantially; Site 2 was gravel dominated, Site 1 gravel and cobble fractions were co-dominant and Site 3 was cobble dominated with a high boulder fraction (Appendix D). Coincidently, the gravel dominated site 2 was by far the lowest sampling density for fry and juvenile bull trout, even though spawning activity within Site 2 was comparable to Site 1.

Table 8. Summary of substrate pebble counts for the Middlefork White River and Blackfoot Creek fish habitat monitoring sites, 2003.

Site	D^{16}(mm)	D^{35}(mm)	D^{50}(mm)	D^{65}(mm)	D^{84}(mm)	D^{95}(mm)
Middlefork Site 1 (Reach)	13.3	41.4	60.9	79	119	173
(Active Channel)	24.9	48.9	62.9	94	138	191
Middlefork Site 2 (Reach)	0.6	6.5	13.2	24	37	44
(Active Channel)	2.7	7.8	13.5	21	33	48
Blackfoot Site 3 (Reach)	23.9	46.8	75.7	108	154	257
(Active Channel)	24.5	53.7	86.7	125	169	230

3.1.3 Channel Surveys

Channel longitudinal and cross sectional profiles were completed for each of the sample stations and were presented in Appendix D. Detailed quantitative summaries are presented in the Stream Classification Form (Appendix E), the Reference Reach Data Summary Form (Appendix F) and the Velocity Calculation Form (Appendix G). The following summarizes the general channel features noted with associated representative photographs.

Middlefork White River Site 1

Site 1 was classified as a C4(1) Rosgen stream type (Figures 6 - 8). The (1) designation refers to the presence of bedrock outcrops that were associated with pools. Although technically this site was designated as gravel dominated (*i.e*. C4) by the D_{50} particle size of 61 mm, this was just 3 mm short of the cobble designation (*i.e*. C3). In addition, the composition of bed materials was 46% gravels and 46% cobbles.

Site 1 was adjacent to historic cutblocks that were clearcut to the streambank in an alternating manner on both sides of the valley. A substantial portion of the riparian habitat remains intact however, and was dominated by over-mature (*i.e*. old-growth) spruce forest within an extensive flood-prone area of side-channels, sloughs and bogs. The channel slope was 0.4% and bankfull width was 25.7 m within a flood-prone width of 190 m.

This site was representative of the upper Middlefork White River “preferred” bull trout spawning and rearing habitat. Site 1 was noted for its habitat heterogeneity, high LWD frequency, high channel sinuosity, and high pool frequency. This site was also noted for spawning substrate, groundwater infiltration, and stability. In large part, the exceptional stream stability can be attributed to the extensive, relatively intact floodplain dominated by old-growth forest and relic channels. Given that clearcuts currently extend to the streambank at three locations for approximately 430 m of the 875 m surveyed and, in addition, aggressive salvage logging is presently underway within the burnt area immediately upstream of this site, the cumulative impacts are a concern for this important bull trout spawning and rearing area.

Figure 6. Representative riparian habitat, Site 1, Middlefork White River, 2003.

Figure 7. Representative riffle cross-section, Site 1, Middlefork White River, 2003.

Figure 8. Representative pool habitat, Site 1, Middlefork White River, 2003.

Middlefork White River Site 2

Site 2 was classified as a C4 Rosgen stream type (Figures 9 and 10). Although this site was representative of the upper Middlefork White River bull trout spawning habitat, and the gravel substrate provided excellent spawning habitat, the homogeneous nature of the substrates (absence of cobble and boulder fractions), result in poor fry and juvenile rearing habitat. However, this site was noted for its high LWD frequency, high pool frequency and high channel sinuosity. These features provide exceptionally high quality bull trout and Westslope cutthroat trout sub-adult and adult rearing and holding habitat. The channel slope was 0.2% and bankfull width was 31.6 m, within a flood-prone width of 297 m.

The cross-sectional area for the representative riffle within this site was over-estimated. This was due to the riffle cross-section transect intersecting the side-channel at a deep pool location. Pool habitat typically has a higher cross-sectional area and this resulted in the over-estimation of cross-sectional area. As a result, velocity and discharge were also over-estimated for this location. In subsequent years, the side-channel cross-section will be offset upstream approximately 20 m to a typical riffle and surveyed as an independent unit.

The sum of the main-channel riffle and side-channel riffle would then be used to more accurately represent the cross-sectional area.

Site 2 had an extensive flood-prone width of 297 m that occupied the entire valley bottom. The flood prone area was extremely wet, with numerous side-channels, sloughs and bogs and was predominately over-mature (*i.e*. old-growth) spruce forest with a tremendous amount of deadfall (Figure 11). In large part, the exceptional stream stability can be attributed to the extensive, intact, floodplain dominated by old-growth forest and relic channels. Given that aggressive salvage logging is presently underway within the burnt area immediately upstream of this site, the cumulative impacts are a concern for this important spawning area.

Figure 9 . Representative riffle habitat, Site 2, Middlefork White River, 2003.

Figure 10. Representative pool habitat, Site 2, Middlefork White River, 2003.

Figure 11. Representative side-channel habitat, Site 2, Middlefork White River, 2003.

Blackfoot Creek Site 3

The headwaters of this tributary were burned by wildfire and some historic salvage logging has occurred. The index site was located at the downstream limit of the wildfire and the west streambank was salvage logged to the streambank (Figure 12). Large inputs of coarse sediment were evident from excessive bank erosion, high gradient tributaries immediately upstream, and avalanches have periodically deposited coarse sediment across the valley bottom, temporarily damming the entire channel. The channel slope was 1.52% and bankfull width was 15.6 m, within a flood-prone width of 147 m.

As a result of infilling, the higher width to depth ratio results in chute cutoffs across large point bars that begin down cutting into a steeper entrenched gully. Subsequently, this results in excessive bank erosion as the channel attempts to decrease stream slope and build a new floodplain by increasing sinuosity and belt width. An increase in sinuosity and belt width can only be accomplished by lateral extension. This process of lateral extension results in predictable, excessive, bank erosion. It was hypothesized that the Blackfoot Creek index site was at this early stage of recovery, where the channel dimension, pattern and profile were undergoing a successional evolution from an F3 stream type to a C3 stream type (Figure 13 and 14). Infilled and abandoned meanders were clearly visible, as were the chute cutoffs and over-steepened and eroding stream banks. Currently, the over-widened bed of the F3 stream type is now the elevation of the new floodplain for the C3 stream type, which gradually incises, reducing the width to depth ratio and increasing the entrenchment ratio. However, there remains a high probability of further degradation and adverse fish habitat impacts, due to future flood events, given the instability of the stream channel and the extreme erosion potential of the over-steepened and eroding stream banks.

Despite the degraded stream channel of the Blackfoot Creek index site, it still maintains bull trout spawning habitat and high densities of rearing juveniles. This was attributed to two dominant features preferred by spawning and rearing bull trout. First, the high densities of juvenile bull trout are due to the very coarse “bony” substrate of large cobbles and small boulders. Bull trout juveniles are benthic orientated and the streambed of Blackfoot Creek provides abundant, high quality interstitial cover habitat preferred by juvenile bull trout. Secondly, the narrow alluvial floodplain that is bounded by steep mountain slopes has contributed to a predominance of sub-surface flow that reaches the mainstem as groundwater. The provision of suitably sized bed materials in a low gradient, low water

velocity location with associated groundwater have been identified as repeating patterns of preferred bull trout spawning habitat.

Figure 12. Upstream view of Blackfoot Creek index site, 2003.

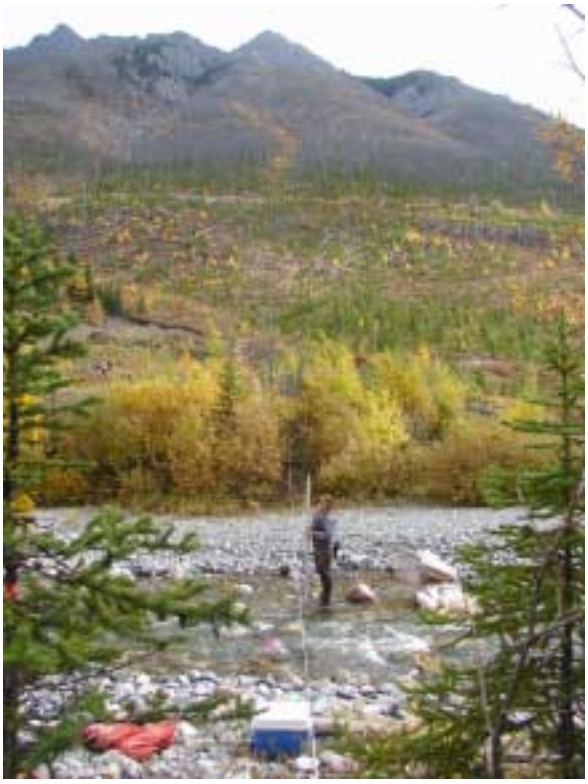


Figure 13. Representative riffle habitat, Site 3, Blackfoot Creek, 2003.

Figure 14. Flood-prone area at the riffle cross-section illustrating old growth forest, relic channel and undisturbed conditions, Blackfoot Creek, 2003.

3.2.3 Fish Habitat Survey (FHAP Form 4)

The Level 1 Fish Habitat Assessment Procedure (FHAP) is a purposive field survey of current habitat conditions for the target species in select reaches. In this study, the Level 1 FHAP Form 4 was completed for the representative sample sites (two meander wavelengths) within the selected reaches. The output of the WRP data reporting tool are presented in Appendix C and have been archived for long-term trend monitoring. Generic diagnostic data have been summarized as descriptors of present habitat condition (Table 9). Cover components utilized by juvenile and adult bull trout and cutthroat trout were interstices, LWD, boulder, depth and overhead vegetation.

Note that regional criteria for habitat conditions do not exist and current WRP diagnostic criteria to evaluate habitat condition are exclusive of bull trout and Westslope cutthroat trout data. Notwithstanding these limitations, diagnostic data clearly indicate the high quality habitat ratings for sites 1 and 2, and the degraded (poor) habitat ratings for Blackfoot Creek. Site 1 contained high value spawning and juvenile rearing habitat with abundant

Table 9. Diagnostics of salmonid habitat condition at the reach level for Middlefork White River and Blackfoot Creek, 2003 (from Johnston and Slaney 1996). Note that the individual cell format represents value/rating[A, B].

		Habitat Parameter											
		Pool % (by area)	Pool Frequency (mean spacing)	LWD Pieces per Bankfull Channel Width	% Wood Cover in Pools	% Boulder Cover in Riffles	% Over-head Cover	Substrate Rearing Habitat (interstitial rating)	Off-Channel Habitat (< 3% gradient)	Holding Pools (> 1 m deep, good cover)	Spawning Gravel Quantity	Spawning Gravel Quality	Redd Scour Potential
Site Middlefork White River	1	18 / P	5.0 / P	13.6 / G	15 / F	2.5 / P	<5 / P	Clear / G	Abundant / G	Frequent / G	Frequent / G	Suitable / G	Stable / G
Site Middlefork White River	2	60 / G	1.5 / G	23 / G	31 / G	0 / P	8 / P	Interstices Filled / P	Abundant / G	Abundant / G	Frequent / G	Sand sub-dom. / F	Stable / G
Site Blackfoot Creek.	3	30 / P	2.9 / F	7.41 / G	31 / P	9.2 / P	4 / P	Clear / G	Limited / P	Few / P	Frequent / G	Suitable / G	Scour / P

A Note: regional standards are not available and diagnostic ratings (G – good, F – fair, P – poor) are generalized ratings from Johnston and Slaney (1996) for streams with a bankfull channel width of less than 15 m.

B Note: two representative meander lengths were surveyed, not the entire reach.

LWD and holding pools for adults. Site 2 contained abundant spawning substrate, high quality adult holding habitat but poor juvenile rearing capability. Blackfoot Creek contained abundant spawning substrate and excellent interstitial habitat for rearing juveniles. Scour potential was high however, and adult holding habitat was limited due to channel infilling.

4 Discussion

The 2003 project year represents the first year of a long-term bull trout-monitoring program with current studies focused on collecting baseline information within the White River watershed. Relative to co-existing species, bull trout densities usually are low, and most broad faunal surveys indicate less than 5% of the total catch is made up of bull trout (McPhail and Baxter 1996, Reiman and McIntyre 1995). However, in the Middlefork White River and Blackfoot Creek index sites, bull trout represented 99.5% of the catch. Fry dominated the catch because site selection was biased towards electrofishing sample sites which favored high bull trout fry capture success. Slimy sculpin were the only other species enumerated. Westslope cutthroat trout were observed and angled from deep pool habitat.

The mean density of all juvenile bull trout was estimated to be 16.6 fish/100m^2. These densities are comparable to the upper Wigwam River bull trout spawning reaches (Table 10), and densities of this magnitude, are some of the highest reported within the species distribution range (Cope 1997).

Table 10. Comparison of bull trout fry and juvenile density estimates for the three most important upper Kootenay River bull trout spawning tributaries.

Watershed	Year	Mean Density (+/- 95% Confidence Interval)	Reference
White R.	2003	16.6 (14.2 – 19.0)	
Skookumchuck Cr.	2003	9.1 (8.2 – 10.2)	Cope 2004
	2002	6.6 (5.9 – 7.3)	Cope 2003a
Wigwam R.	2002	12.7 (11.5 – 14.0)	Cope 2003b
	2001	20.7 (18.1 – 24.0)	Cope *et. al*. 2002
	2000	17.2 (14.7 – 21.6)	Cope and Morris 2001
	1997	14.9 (12.4 – 18.1)	Cope 1998

Within the Flathead River system, areas with combined fry and juvenile densities greater than 1.5 fish per 100 m^2 were cited as critical rearing areas (Goetz 1989). Furthermore, the Site 1 (Middlefork) densities were the highest single site densities reported in the five years of sampling for this program. Based on these comparisons, the upper Middlefork White River and Blackfoot Creek should be considered critical spawning and rearing habitat for the upper Kootenay River population of bull trout.

Maximum summer water temperatures of 14 – 18^{o}C appear to limit bull trout distribution (Baxter and McPhail 1996) and the high water quality of the Middlefork White River and Blackfoot Creek were reflected in the low maximum summer water temperatures (spot samples taken at 16:00) and ubiquitous juvenile bull trout distribution.

Trends in abundance appeared to be related to proximity to spawning areas, bed material size, and water depth. The association of bull trout fry with shallow (5 – 20 cm), low velocity (<0.3 m/s), cobble dominated stream margin habitat has been previously documented within the Wigwam River (Cope 2003b). Cobbles and gravels that provide prime spawning and juvenile rearing habitat dominate the upper Middlefork and Blackfoot Creek. The exception was Site 2, where the gravel and sand dominated substrate were clearly not suitable for fry and juvenile rearing. Given that a large number of redds are annually enumerated within this site, a downstream displacement of fry to more suitable benthic cover (cobbles) would explain the very high densities observed at Site 2. Cover components utilized by juvenile and adult bull trout and cutthroat trout were interstices, LWD, boulder, depth and overhead vegetation.

The range of morphological stream types for the Middlefork White River encompasses the stable and resilient spectrum (C4(1) and C4). The index sites can be generalized as a slightly entrenched, meandering, riffle-pool, gravel-cobble dominated channel with a well developed floodplain. High LWD frequency, high pool frequency and high channel sinuosity provide exceptionally high habitat complexity with high quality bull trout and Westslope cutthroat trout spawning and rearing habitat, for all life stages. In large part, the exceptional habitat diversity and stream stability can be attributed to the extensive, intact, floodplain dominated by old-growth forest and relic channels. The results of the habitat assessment concur with the stable stream channel type and channel disturbance features noted were infrequent and minor in nature. Aggressive salvage logging is presently underway within the burnt area immediately adjacent and upstream of this site. Caution is advised as the cumulative impacts of wildfire and salvage logging are a concern for this important bull trout spawning and rearing area.

The cross-sectional area for the representative riffle within site 2 was over-estimated. This was due to the riffle cross-section transect intersecting the side-channel at a deep pool location. Pool habitat typically has a higher cross-sectional area and this resulted in the over-estimation of cross-sectional area. As a result, velocity and discharge were also over-estimated for this location. In subsequent years, the side-channel cross-section should be offset upstream approximately 20 m to a typical riffle and surveyed as an independent unit. The sum of the main-channel riffle and side-channel riffle would then be used to more accurately represent the cross-sectional area.

Blackfoot Creek, in contrast, was considered severely degraded and unstable. The headwaters of this tributary were burned by wildfire and some historic salvage logging has occurred. The index site was located at the downstream limit of the wildfire, the west streambank was salvage logged to the streambank, and large inputs of coarse sediment were evident. Although it was hypothesized that the Blackfoot Creek index site was at an early stage of recovery, there remains a high probability of further degradation and adverse fish habitat impacts, due to future flood events, given the instability of the stream channel and the extreme erosion potential of the over-steepened and eroding stream banks.

Despite the degraded nature of the Blackfoot Creek index site, it still maintains bull trout spawning habitat and high densities of rearing juveniles. This was attributed to two dominant features preferred by spawning and rearing bull trout. First, the high densities of juvenile bull trout are due to the very coarse “bony” substrate of large cobbles and small boulders. Bull trout juveniles are benthic orientated and the stream bed of Blackfoot Creek provides abundant, high quality interstitial cover habitat preferred by juvenile bull trout. Secondly, the narrow alluvial floodplain that is bounded by steep mountain slopes has contributed to a predominance of sub-surface flow that reaches the mainstem as groundwater. The provision of suitably sized bed materials in a low gradient, low water velocity location with associated groundwater have been identified as repeating patterns of preferred bull trout spawning habitat.

5 Recommendations

The main side-channel, within Site 2, was not discovered until after electrofishing was completed. This habitat provides the highest bull trout fry and juvenile rearing capability and at least one electrofishing habitat unit should be re-directed to this location.

Given the extremely wide floodplain of site two, benchmarks should be established at each of the side-channel cross-sections. Side-channel units could then be surveyed independently and the cross-sectional area of the side-channel and mainstem units summed to represent the cross-sectional area for this site. The riffle cross-sectional transect for the side-channel should be offset upstream approximately 20 m to incorporate a typical riffle.

Inclusion of a snorkel survey in sites one and two (Middlefork White River) would provide valuable index data for Westslope cutthroat trout. The glacial nature of the headwaters makes visibility a concern however, if the snorkel survey was delayed until late September water clarity should be sufficient to facilitate such a survey.

6 References

Anon. 1998. Manual of standard operating procedures for hydrometric surveys in British Columbia. Resource Inventory Branch, BC Environment, Victoria, BC. 168 p + app.

Baxter, J.S. and J.T.A. Baxter. 2002. Summary of the Skookumchuck Creek bull trout enumeration project (2000-2002). Report prepared for Ministry of Water, Land and Air Protection, Cranbrook, B.C. Report prepared by Baxter Environmental, Nelson, B.C.

Baxter, J.S. and W.T. Westover. 2000. An overview of the Wigwam River bull trout program (1995-1999): Habitat Conservation Trust Fund final report. Fisheries Project Report KO 58, vi+23p.

Baxter, J.S. and J.D. McPhail. 1996. Bull trout spawning and rearing habitat requirements: summary of the literature. British Columbia Ministry of Environment, Lands, and Parks, Fisheries Branch, Fort St. John, British Columbia. 108 p.

Braumandl, T.F. and M.P. Curran [eds.]. 1992. A field guide for site identification and interpretation for the Nelson Forest Region. British Columbia, Ministry of Forests, Land Management Handbook No. 20.

Buchanan, D.V. and S.T. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 119 – 126 *In* Mackay, W.C., M.K. Brewin, and M. Monita. [*eds*.]. Friends of the bull trout conference proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary.

Cannings, S.G. 1993. Rare freshwater fish of British Columbia. Conservation Data Centre, Report #1. B.C. Ministry of Water, Land, and Air Protection. Victoria, B.C.

Cope, R.S. 2004. Skookumchuck Creek juvenile bull trout and fish habitat monitoring program: 2003 data report. Prepared for the Ministry of Land, Water, and Air Protection, Cranbrook, B.C. Prepared by Westslope Fisheries Ltd., Cranbrook, B.C. 40 pp + 7 app.

Cope, R.S. 2003a. Skookumchuck Creek juvenile bull trout and fish habitat monitoring program: 2002 data report (Activity No. 2000-004-00). Prepared for the Ministry of Land, Water, and Air Protection, Cranbrook, B.C. Prepared by Westslope Fisheries Ltd., Cranbrook, B.C. 28 pp + 7 app.

Cope, R.S. 2003b. Wigwam River juvenile bull trout and fish habitat monitoring program: 2002 data report (Activity No. 2000-004-00). Prepared for the Ministry of Land, Water, and Air Protection, Cranbrook, B.C. Prepared by Westslope Fisheries, Cranbrook, B.C. 35 pp + 5 app.

Cope, R.S., and K. Morris. 2004. Summary of the White River bull trout enumeration project (2003). Prepared for the Ministry of Land, Water, and Air Protection, Cranbrook, B.C. Prepared by Westslope Fisheries Ltd., Cranbrook, B.C. 19 pp

Cope, R.S., K. Morris and J.E. Bisset. 2002. Wigwam River juvenile bull trout and fish habitat monitoring program: 2001 data report (Activity No. 2000-004-01). Report Prepared for the Ministry of Land, Water, and Air Protection, Cranbrook, B.C. Prepared by Westslope Fisheries Ltd., Cranbrook, B.C. 28pp. + 5 app.

Cope, R.S. and K.J. Morris. 2001. Wigwam River juvenile bull trout and fish habitat monitoring program: 2000 data report. Report Prepared for B.C. Ministry of Environment, Lands and Parks, Fisheries Branch, Cranbrook, B.C. Prepared by Westslope Fisheries Ltd., Cranbrook, B.C. 33 pp. + 4 app.

Cope, R.S. 1998. Wigwam River fish - forestry study: preliminary surveys (1997). Report Prepared for Ministry of Environment, Lands and Parks, Nelson, B.C. Prepared by Interior Reforestation Co. Ltd. 52 p. + 4 app.

Fisheries Information Summary System (FISS). 2002. Webpage- Fisheries Data Warehouse, B.C. Ministry of Sustainable Resource management.

Goetz, F.A. 1989. Biology of the bull trout, a literature review. U.S.D.A., Willamette National Forest, Eugene Oregon. 53 p.

Hundal, L.S. 2001. Restoration plan Middle Fork White River. Report Prepared for Slocan Forest Products Ltd., Radium, B.C. Prepared by AMEC Earth & Environmental Limited, Calgary, Alberta. 37 pp. +4 app.

Johnston, N.T. and P.A. Slaney. 1996. Fish habitat assessment procedures. Watershed Restoration Technical Circular No. 8. Watershed Restoration Program, Ministry of Water, Land, and Air Protection and Ministry of Forests. Vancouver, British Columbia. 67 p. + app.

McPhail, J.D. and J. Baxter. 1996. A review of bull trout (Salvelinus confluentus) life history and habitat use in relation to compensation and improvement opportunities. B.C. Fisheries Management Report No. 104. 58 p.

Prince, A., and K. Morris. 2003. Upper Wigwam River water quality and quantity monitoring program 2002 data report (Activity No. 01-RIP-FRBC-502). Report prepared for Crestbrook Forest Industries Ltd., Cranbrook, B.C. Prepared by Westslope Fisheries, Cranbrook, B.C. 61 pp. + 3 app.

Reiman, B.E. and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Trans. Am. Fish. Soc. 124: 285-297.

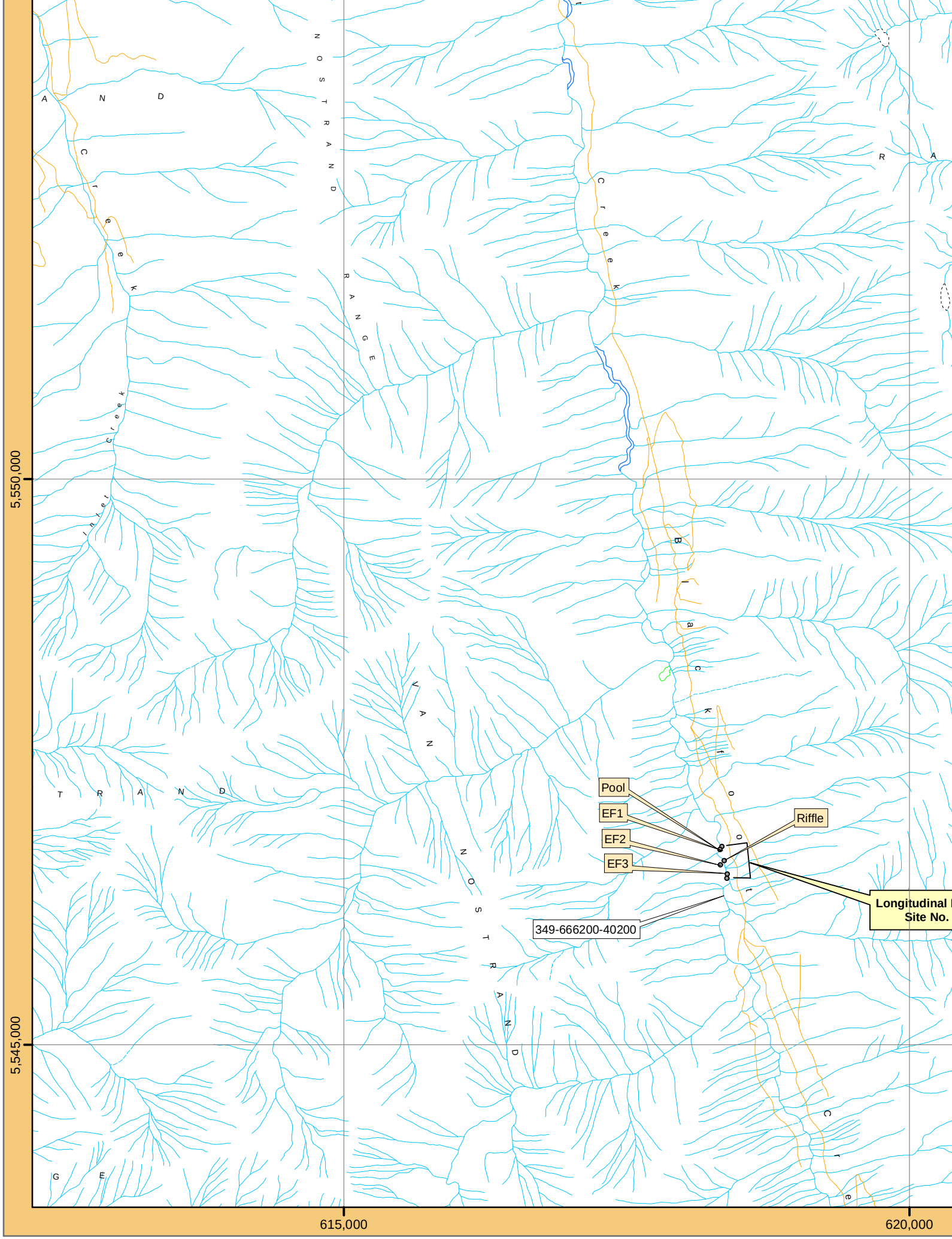
Riley, S.C. and K.D. Fausch. 1992. Under estimation of trout population size by maximum-likelihood removal estimates in small streams. N. Am. J. Fish. Mgmt. 12: 768-776.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, Colorado. 343 p. + app.

Van Deventer, J.S. and W.S. Platts. 1990. Microcomputer software system for generating population statistics from electrofishing data, users guide for Microfish 3.0. USDA Forest Service, Intermountain Forest and Range Experiment Station Gen. Tech. Rep. INT-254. Ogden UT.

Appendix A

1:50,000 TRIM Map


Pool
EF1
EF2
EF3
Riffle
349-666200-40200
Longitudinal
Site No.
5,550,000
5,545,000
615,000
620,000

Appendix B

Fish Capture Data

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-000 1.0

WATERBODY

Gazetted Name: WHITE RIVER Local: Middlefork White R.(KM 61 FSR)

Project Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-0

WS Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-000

Waterbody ID: ILP Map #: ILP #: Reach #: 1 -

Project ID: 10585 Lake/Stream: S Lake From Date:

Fish Permit #: 03-4-0990 Date: 2003/08/10 To: 2003/08/10 Agency: C214 Crew: AP/KM/SC Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3			11	627966	5572612	GP3	EF	1	8.7	320	C	Glide margin
2			11	627946	5572643	GP3	EF	1	6.3	318	C	Pool Margin
1			11	627916	5572739	GP3	EF	1	4.9	290	C	Riffle Margin

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2003/08/10	09:15	2003/08/10	09:45	Photo 78, 77, 76
1	EF	1	2	2003/08/10	09:47	2003/08/10	10:15	
1	EF	1	3	2003/08/10	10:18	2003/08/10	10:44	
2	EF	1	1	2003/08/10	11:15	2003/08/10	11:49	Photo 79, 80, 81,81
2	EF	1	2	2003/08/10	11:53	2003/08/10	12:17	
2	EF	1	3	2003/08/10	12:20	2003/08/10	12:38	
3	EF	1	1	2003/08/10	15:29	2003/08/10	16:00	Photo 84, 83, 82
3	EF	1	2	2003/08/10	16:02	2003/08/10	16:22	
3	EF	1	3	2003/08/10	16:30	2003/08/10	17:00	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1343	28.0	4.0	300	60	6	SR	12A
1	EF	1	2	C	987	28.0	4.0	300	60	6	SR	12A
1	EF	1	3	C	900	28.0	4.0	300	60	6	SR	12A
2	EF	1	1	C	1064	27.2	3.3	200	60	6	SR	12A
2	EF	1	2	C	877	27.2	3.3	200	60	6	SR	12A
2	EF	1	3	C	886	27.2	3.3	200	60	6	SR	12A
3	EF	1	1	C	1022	17.5	11.0	300	60	6	SR	12A
3	EF	1	2	C	986	17.5	11.0	300	60	6	SR	12A
3	EF	1	3	C	916	17.5	11.0	300	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	BT	F	0	37	33	62	R	
1	EF	1	2	CCG	A	U	1	67	67	R	Keyed out to Slimy Sculpin
1	EF	1	2	BT	F	0	18	40	59	R	
1	EF	1	3	BT	F	0	17	37	63	R	
2	EF	1	1	BT	J	1	1	90	90	R	
2	EF	1	1	BT	F	O	4	43	53	R	
2	EF	1	2	BT	F	0	4	41	52	R	
2	EF	1	3	BT	F	0	2	47	48	R	
3	EF	1	1	BT	J	1	3	90	129	R	
3	EF	1	1	BT	F	0	7	38	56	R	
3	EF	1	2	BT	J	1	3	86	93	R	
3	EF	1	2	BT	F	0	6	41	51	R	
3	EF	1	3	BT	F	0	4	43	55	R	

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	37	.5	U	U			FRY						
1	EF	1	1	BT	62	2.4	U	U			0						
1	EF	1	1	BT	59	2.0	U	U			0						
1	EF	1	1	BT	54	1.5	U	U			0						
1	EF	1	1	BT	45	.8	U	U			0						

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-000 1.0

INDIVIDUAL FISH DATA																		
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	37	.4	U	U			0						
1	EF	1	1	BT	33	.4	U	U			0						
1	EF	1	1	BT	50	1.5	U	U			0						
1	EF	1	1	BT	55	1.6	U	U			0						
1	EF	1	1	BT	54	1.6	U	U			0						
1	EF	1	1	BT	44	.7	U	U			0						
1	EF	1	1	BT	46	.9	U	U			0						
1	EF	1	1	BT	44	.8	U	U			0						
1	EF	1	1	BT	47	1.0	U	U			0						
1	EF	1	1	BT	56	2.0	U	U			0						
1	EF	1	1	BT	54	1.8	U	U			0						
1	EF	1	1	BT	55	1.7	U	U			0						
1	EF	1	1	BT	47	1.1	U	U			0						
1	EF	1	1	BT	54	1.9	U	U			0						
1	EF	1	1	BT	51	1.3	U	U			0						
1	EF	1	1	BT	42	1.0	U	U			0						
1	EF	1	1	BT	46	1.2	U	U			0						
1	EF	1	1	BT	39	.7	U	U			0						
1	EF	1	1	BT	48	1.0	U	U			0						
1	EF	1	1	BT	59	1.9	U	U			0						
1	EF	1	1	BT	52	1.6	U	U			0						
1	EF	1	1	BT	60	2.0	U	U			0						
1	EF	1	1	BT	55	1.6	U	U			0						
1	EF	1	1	BT	45	.9	U	U			0						
1	EF	1	1	BT	56	1.7	U	U			0						
1	EF	1	1	BT	50	1.2	U	U			0						
1	EF	1	1	BT	50	1.2	U	U			0						
1	EF	1	1	BT	49	1.5	U	U			0						
1	EF	1	1	BT	48	.9	U	U			0						
1	EF	1	1	BT	43	.8	U	U			0						
1	EF	1	1	BT	48	1.0	U	U			0						
1	EF	1	1	BT	45	1.0	U	U			0						
1	EF	1	2	BT	54	1.5	U	U			0						
1	EF	1	2	BT	55	1.9	U	U			0						
1	EF	1	2	BT	46	1.0	U	U			0						
1	EF	1	2	BT	48	1.2	U	U			0						
1	EF	1	2	BT	48	1.0	U	U			0						
1	EF	1	2	BT	46	1.0	U	U			0						
1	EF	1	2	BT	45	.9	U	U			0						
1	EF	1	2	BT	59	1.9	U	U			0						
1	EF	1	2	BT	50	1.3	U	U			0						
1	EF	1	2	BT	48	1.5	U	U			0						
1	EF	1	2	BT	48	1.3	U	U			0						
1	EF	1	2	BT	48	1.0	U	U			0						
1	EF	1	2	BT	40	.6	U	U			0						
1	EF	1	2	CCG	67	3.6	U	U			0						Keyed out to slimy sculpin
1	EF	1	2	BT	51	1.8	U	U			0						
1	EF	1	2	BT	48	1.5	U	U			0						
1	EF	1	2	BT	42	.7	U	U			0						
1	EF	1	2	BT	40	.6	U	U			0						
1	EF	1	2	BT	57	1.9	U	U			0						
1	EF	1	3	BT	48	1.2	U	U			0						
1	EF	1	3	BT	48	1.5	U	U			0						
1	EF	1	3	BT	42	1.0	U	U			0						
1	EF	1	3	BT	45	.9	U	U			0						
1	EF	1	3	BT	46	1.0	U	U			0						
1	EF	1	3	BT	48	1.1	U	U			0						

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-000 1.0

INDIVIDUAL FISH DATA																		
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	3	BT	44	.8	U	U			0						
1	EF	1	3	BT	46	1.0	U	U			0						
1	EF	1	3	BT	43	.8	U	U			0						
1	EF	1	3	BT	38	.8	U	U			0						
1	EF	1	3	BT	45	1.0	U	U			0						
1	EF	1	3	BT	63	2.7	U	U			0						
1	EF	1	3	BT	49	1.4	U	U			0						
1	EF	1	3	BT	37	.6	U	U			0						
1	EF	1	3	BT	44	1.4	U	U			0						
1	EF	1	3	BT	46	1.4	U	U			0						
1	EF	1	3	BT	47	1.2	U	U			0						
2	EF	1	1	BT	43	.9	U	U			0						
2	EF	1	1	BT	90	7.2	U	U			1						
2	EF	1	1	BT	53	1.4	U	U			0						
2	EF	1	1	BT	47	1.0	U	U			0						
2	EF	1	1	BT	43	.9	U	U			0						
2	EF	1	2	BT	41	.8	U	U			0						
2	EF	1	2	BT	43	.9	U	U			0						
2	EF	1	2	BT	46	1.0	U	U			0						
2	EF	1	2	BT	52	1.7	U	U			0						
2	EF	1	3	BT	47	1.1	U	U			0						
2	EF	1	3	BT	48	1.2	U	U			0						
3	EF	1	1	BT	56	2.1	U	U			0						
3	EF	1	1	BT	38	.6	U	U			0						
3	EF	1	1	BT	45	1.3	U	U			0						
3	EF	1	1	BT	45	.9	U	U			0						
3	EF	1	1	BT	52	1.6	U	U			0						
3	EF	1	1	BT	55	1.8	U	U			0						
3	EF	1	1	BT	90	7.7	U	U			1						
3	EF	1	1	BT	121	19.5	U	U			1						
3	EF	1	1	BT	52	1.5	U	U			0						
3	EF	1	1	BT	129	29.5	U	U			1						
3	EF	1	2	BT	47	1.2	U	U			0						
3	EF	1	2	BT	86	6.8	U	U			1						
3	EF	1	2	BT	86	6.8	U	U			1						
3	EF	1	2	BT	93	9.0	U	U			1						
3	EF	1	2	BT	44	1.3	U	U			0						
3	EF	1	2	BT	47	1.2	U	U			0						
3	EF	1	2	BT	50	1.5	U	U			0						
3	EF	1	2	BT	41	1.0	U	U			0						
3	EF	1	2	BT	51	1.5	U	U			0						
3	EF	1	3	BT	55	2.2	U	U			0						
3	EF	1	3	BT	43	1.0	U	U			0						
3	EF	1	3	BT	45	1.0	U	U			0						
3	EF	1	3	BT	44	1.1	U	U			0						

COMMENTS

Section	Comments
WATERBODY	Middlefork Wildfire and suppresion activity visible 4 km upstream.

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-000 2.0

WATERBODY

Gazetted Name: WHITE RIVER Local: Middlefork White R.(KM 64 FSR)

Project Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-0

WS Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-000

Waterbody ID: ILP Map #: ILP #: Reach #: 2 -

Project ID: 10585 Lake/Stream: S Lake From Date:

Fish Permit #: 03-4-0990 Date: 2003/08/09 To: 2003/08/09 Agency: C214 Crew: AP/KM/SC Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3			11	627239	5575591	GP3	EF	1	8.3	300	C	Side channel
2			11	627211	5575611	GP3	EF	1	6.2	302	C	Pool Margin
1			11	627172	5575527	GP3	EF	1	5.5	292	C	Riffle Margin

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2003/08/09	10:16	2003/08/09	10:40	Photos 66, 67, 68
1	EF	1	2	2003/08/09	10:42	2003/08/09	11:05	
1	EF	1	3	2003/08/09	11:05	2003/08/09	11:22	
2	EF	1	1	2003/08/09	12:12	2003/08/09	12:30	Photos 71, 70, 69
2	EF	1	2	2003/08/09	12:33	2003/08/09	12:49	
2	EF	1	3	2003/08/09	12:50	2003/08/09	13:06	
3	EF	1	1	2003/08/09	15:07	2003/08/09	15:24	Photos 72, 73, 74- First 10m nice gravel then soft mud substrate

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1189	14.0	12.0	200	60	6	SR	12A
1	EF	1	2	C	968	14.0	12.0	200	60	6	SR	12A
1	EF	1	3	C	882	14.0	12.0	200	60	6	SR	12A
2	EF	1	1	C	1042	25.0	5.0	200	60	6	SR	12A
2	EF	1	2	C	864	25.0	5.0	200	60	6	SR	12A
2	EF	1	3	C	797	25.0	5.0	200	60	6	SR	12A
3	EF	1	1	C	987	30.0	4.0	200	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	BT	F	0	3	44	52	R	
1	EF	1	2	BT	F	0	2	46	55	R	
2	EF	1	1	BT	F	0	1	44	44	R	

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	47	1.1	U	U			0						
1	EF	1	1	BT	52	1.5	U	U			0						
1	EF	1	1	BT	44	.7	U	U			0						
1	EF	1	2	BT	55	1.7	U	U			0						
1	EF	1	2	BT	46	.8	U	U			0						
2	EF	1	1	BT	44	1.3	U	U			0						

COMMENTS

Section	Comments
WATERBODY	Side-channel site most soft mud with lots of LWD. Better side-channel found during survey cross-section
WATERBODY	Wildfire immediately upstream; Helicopters bucketing immediately upstream; Fireguard on-site

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-666200-40200-00000-0000-0000-000-000-000-000-000-000 1.0

WATERBODY

Gazetted Name: BLACKFOOT CREEK Local: Blackfoot Cr (KM 48 FSR)

Project Code: 349-666200-00000-00000-0000-0000-000-000-000-000-000-0

WS Code: 349-666200-40200-00000-0000-0000-000-000-000-000-000-000

Waterbody ID: ILP Map #: ILP #: Reach #: 1 -

Project ID: 10585 Lake/Stream: S Lake From Date:

Fish Permit #: 03-4-0990 Date: 2003/08/08 To: 2003/08/08 Agency: C214 Crew: AP/KM/SC Resample: ☐

SITE / METHOD

Site#	NID Map	NID #	UTM:Zone/East/North/Mthd				MTD/NO		Temp	Cond	Turbid	Comment
3			11	618391	5546509	GP3	EF	1	11.2	243	C	Glide
2			11	618331	5546589	GP3	EF	1	11.5	241	C	Riffle
1			11	618329	5546725	GP3	EF	1	6.4	222	C	Pool

A. GEAR SETTINGS

Site#	MTD/NO		H/P	Date In	Time In	Date Out	Time Out	Comment
1	EF	1	1	2003/08/08	11:00	2003/08/08	11:34	Photos 50, 49, 48
1	EF	1	2	2003/08/08	11:35	2003/08/08	12:00	
1	EF	1	3	2003/08/08	12:05	2003/08/08	12:22	
2	EF	1	1	2003/08/08	13:04	2003/08/08	13:35	Photos 53, 52, 51
2	EF	1	2	2003/08/08	13:37	2003/08/08	14:00	
2	EF	1	3	2003/08/08	14:03	2003/08/08	14:25	
3	EF	1	1	2003/08/08	16:29	2003/08/08	16:50	Photos 54, 55, 56, 57
3	EF	1	2	2003/08/08	16:55	2003/08/08	17:14	
3	EF	1	3	2003/08/08	17:16	2003/08/08	17:35	

C. ELECTROFISHER SPECIFICATIONS

Site#	MTD/NO		H/P	Encl	Sec	Length	Width	Voltage	Frequency	Pulse	Make	Model
1	EF	1	1	C	1184	27.0	7.0	200	60	6	SR	12A
1	EF	1	2	C	931	27.0	7.0	200	60	6	SR	12A
1	EF	1	3	C	902	27.0	7.0	200	60	6	SR	12A
2	EF	1	1	C	1216	20.0	7.6	200	60	6	SR	12A
2	EF	1	2	C	912	20.0	7.6	200	60	6	SR	12A
2	EF	1	3	C	900	20.0	7.6	200	60	6	SR	12A
3	EF	1	1	C	1019	16.5	10.7	200	60	6	SR	12A
3	EF	1	2	C	1015	16.5	10.7	200	60	6	SR	12A
3	EF	1	3	C	865	16.5	10.7	200	60	6	SR	12A

FISH SUMMARY

Site#	MTD/NO		H/P	Species	Stage	Age	Total #	Lgth (Min/Max)		FishAct	Comment
1	EF	1	1	BT	J	1	6	79	118	R	
1	EF	1	1	BT	F	0	10	37	52	R	
1	EF	1	2	BT	F	0	2	47	51	R	
1	EF	1	2	BT	J	1	3	89	107	R	
1	EF	1	3	BT	F	0	1	46	46	R	
1	EF	1	3	BT	J	1	1	94	94	R	
1	EF	1	3	BT	J	2	1	160	160	R	
2	EF	1	1	BT	J	1	2	92	121	R	
2	EF	1	1	BT	F	0	14	38	51	R	
2	EF	1	2	BT	J	1	2	84	89	R	
2	EF	1	2	BT	F	0	4	42	51	R	
2	EF	1	3	BT	F	0	4	43	48	R	
2	EF	1	3	BT	J	1	2	118	136	R	
3	EF	1	1	BT	F	0	7	44	53	R	
3	EF	1	1	BT	J	1	3	86	139	R	
3	EF	1	2	BT	F	0	5	41	50	R	
3	EF	1	3	BT	J	1	1	117	117	R	
3	EF	1	3	BT	F	0	1	46	46	R	

INDIVIDUAL FISH DATA

Site#	MTD/NO	H/P	Species	Length	Weight	Sex	Mat	Age Str/Smpl#/Age	Vch#	Genetic Str/Smpl#	Roll #	Frame#	Comment

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-666200-40200-00000-0000-0000-000-000-000-000-000-000 1.0

INDIVIDUAL FISH DATA																	
Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
1	EF	1	1	BT	118	21.7	U	U			1						
1	EF	1	1	BT	122	17.4	U	U			1						
1	EF	1	1	BT	84	6.9	U	U			1						
1	EF	1	1	BT	91	7.7	U	U			1						
1	EF	1	1	BT	79	5.5	U	U			1						
1	EF	1	1	BT	47	.9	U	U			0						
1	EF	1	1	BT	37	.4	U	U			0						
1	EF	1	1	BT	47	.9	U	U			0						
1	EF	1	1	BT	46	1.2	U	U			0						
1	EF	1	1	BT	44	.8	U	U			0						
1	EF	1	1	BT	41	.8	U	U			0						
1	EF	1	1	BT	47	1.2	U	U			0						
1	EF	1	1	BT	52	1.5	U	U			0						
1	EF	1	1	BT	83	5.9	U	U			1						
1	EF	1	1	BT	45	1.6	U	U			0						
1	EF	1	1	BT	42	.9	U	U			0						
1	EF	1	2	BT	89	6.5	U	U			1						
1	EF	1	2	BT	47	.9	U	U			0						
1	EF	1	2	BT	89	7.2	U	U			1						
1	EF	1	2	BT	107	12.8	U	U			1						
1	EF	1	2	BT	51	2.1	U	U			0						
1	EF	1	3	BT	160	46.7	U	U			2						
1	EF	1	3	BT	94	9.4	U	U			1						
1	EF	1	3	BT	46	1.0	U	U			0						
2	EF	1	1	BT	92	8.8	U	U			1						
2	EF	1	1	BT	44	.8	U	U			0						
2	EF	1	1	BT	51	1.4	U	U			0						
2	EF	1	1	BT	46	.6	U	U			0						
2	EF	1	1	BT	41	.6	U	U			0						
2	EF	1	1	BT	45	.8	U	U			0						
2	EF	1	1	BT	121	18.5	U	U			1						
2	EF	1	1	BT	48	1.0	U	U			0						
2	EF	1	1	BT	49	1.3	U	U			0						
2	EF	1	1	BT	46	.9	U	U			0						
2	EF	1	1	BT	46	.9	U	U			0						
2	EF	1	1	BT	46	.9	U	U			0						
2	EF	1	1	BT	47	1.0	U	U			0						
2	EF	1	1	BT	46	1.1	U	U			0						
2	EF	1	1	BT	45	.9	U	U			0						
2	EF	1	1	BT	38	.5	U	U			0						
2	EF	1	2	BT	47	1.0	U	U			0						
2	EF	1	2	BT	42	.9	U	U			0						
2	EF	1	2	BT	84	6.6	U	U			1						
2	EF	1	2	BT	89	7.2	U	U			1						
2	EF	1	2	BT	51	1.5	U	U			0						
2	EF	1	2	BT	43	.8	U	U			0						
2	EF	1	3	BT	43	.7	U	U			0						
2	EF	1	3	BT	43	.8	U	U			0						
2	EF	1	3	BT	46	1.0	U	U			0						
2	EF	1	3	BT	48	1.0	U	U			0						
2	EF	1	3	BT	136	26.6	U	U			1						
2	EF	1	3	BT	118	17.6	U	U			1						
3	EF	1	1	BT	109	13.7	U	U			1						
3	EF	1	1	BT	53	1.3	U	U			0						
3	EF	1	1	BT	48	1.1	U	U			0						
3	EF	1	1	BT	47	1.0	U	U			0						
3	EF	1	1	BT	139	29.9	U	U			1						

FDIS Fish Card

Reach # ILP Map # ILP #

Watershed Code: 349-666200-40200-00000-0000-0000-000-000-000-000-000-000 1.0

INDIVIDUAL FISH DATA

Site#	MTD/NO		H/P	Species	Length	Weight	Sex	Mat	Age			Vch#	Genetic		Roll #	Frame#	Comment
									Str/Smpl#/Age				Str/Smpl#				
3	EF	1	1	BT	86	6.2	U	U			1						
3	EF	1	1	BT	46	.9	U	U			0						
3	EF	1	1	BT	44	1.0	U	U			0						
3	EF	1	1	BT	48	1.1	U	U			0						
3	EF	1	1	BT	51	1.2	U	U			0						
3	EF	1	2	BT	46	1.0	U	U			0						
3	EF	1	2	BT	50	1.1	U	U			0						
3	EF	1	2	BT	45	.9	U	U			0						
3	EF	1	2	BT	45	1.0	U	U			0						
3	EF	1	2	BT	41	.6	U	U			0						
3	EF	1	3	BT	117	16.9	U	U			1						
3	EF	1	3	BT	46	1.0	U	U			0						

COMMENTS

Section	Comments
WATERBODY	Adult BT Spawners VO in pools

Appendix C

FHAP Level 1 Form 4 Data

Level 1 - Habitat Summary Diagnosis Report

Form Number:	104
Forest District:	
Watershed Name:	WHITE RIVER
Watershed Code:	349-666200-00000-00000-0000-0000-000-000-000-000-000-000
Survey Date:	9/26/2003
Weather:	Sunny
Survey Crew:	SC/KM
Discharge:	8.52 (cubic meters per second)

Subsampling Fractions:

Riffles	1 in 1	Pools	1 in 1	Glides	1 in 1	Cascades	1 in 1	Other	1 in 1

NTS Maps (1:50,000) :	082J06	BGGS Maps (1:20,000) :	082J034
			082J035
			082J024
			082J025

Detail No	Sub Basin Name	Reach No	Section No	UTM			Distance (m)	Habitat Unit		Length (m)	Grad (%)	Mean Depth		Mean Width		Pools Only			
				Zone	Easting	Northing		Type	Cat			Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth	Crest (m)	Residual	Pool Type
1	MIDDLEFORK	1	1	11	627901	5572778	50	R	1	128	0.552	1.16	0.48	25.4	24.4				
								Comments :											
								redds (BT) - Clearcut to RUB bank; riffle x-sectn											
2	MIDDLEFORK	1	1	11	627929	5572568	178	P	1	45	0.056	1.66	1.09	25	15	1.3	0.45	0.85	S
								Comments :											
								Pool Xsectn-Clearcut to RUB bank											
3	MIDDLEFORK	1	1				223	G	1	17	0.265	1.21	0.68	25	21				
								Comments :											
4	MIDDLEFORK	1	1				240	R	1	80	0.328	1.2	0.61	26	18				
								Comments :											
								redds											

Form Number:
104

Bed Material Type						Total	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Riparian Vegetation			Barriers
Dom.	Sub-Dom.	D90 (mm)	Compaction	SG Type	SG Amt	LWD Tally	10 - 20cm	20 - 50cm	>50c	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type	Structure	Canopy Closure	
C	G	175	L	R	H	71	52	14		LWD	15	C	5							C	MF	1	N
G	C	100	L	R	H	53	31	14	1	LWD	35	C	5	SC	G	250				C	MF	1	N
G	C	125	L	R	H	6	4	2		LWD	10	C	5							C	MF	1	N
G	C	125	L	R	H	42	18	9		LWD	20	C	5							C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

5	MIDDLEFORK	1	1				320	R	1	16	0.857	1.15	0.55	27	16			

Comments :

6	MIDDLEFORK	1	1				336	P	1	12	0	1.75	1.15	23	21	1.35	0.6	0.75	S

Comments :

7	MIDDLEFORK	1	1				347	R	1	103	0.413	1.16	0.62	25	21.5			

Comments :

8	MIDDLEFORK	1	1				450	R	1	35	0.867	0.9	0.34	22	20			

Comments :

9	MIDDLEFORK	1	1				490	P	1	22	0.078	1.5	0.95	17	13	1	0.5	0.5	S

Comments :

Clearcut to RUB bank

10	MIDDLEFORK	1	1				512	R	1	72	0.567	1.2	0.55	17	16			

Comments :

Clearcut to RUB bank

11	MIDDLEFORK	1	1				584	P	1	36	0.124	2.5	2.03	13	10	2.8	0.4	2.4	S

Comments :

redds

12	MIDDLEFORK	1	1				620	R	1	160	0.451	1.1	0.59	22.5	17			

Comments :

redds

13	MIDDLEFORK	1	1				780	R	1	30	0.7	0.9	0.33	26	23			

Comments :

Clearcut to LUB bank

14	MIDDLEFORK	1	1	11	627993	5572274	810	P	1	30	0.05	2	1.27	19.5	12.5	1.4	0.35	1.05	S

Comments :

clearcut to lub bank

C	G	175	L	R	H	1				SWD	2	C	5							C	MF	1	N
G	C	100	L	R	H	6	3			LWD	10	C	5							C	MF	1	N
G	C	125	L	R	H	55	30	19	1	LWD	10	C	5	SC	G	400				C	MF	1	N
C	G	175	L	R	H	6	5	1		LWD	2	C	2							C	MF	1	N
C	B	350	L	R	L	19	10	4	1	B	20	LWD	10							C	MF	1	N
C	B	300	L	R	L	38	19	7	1	B	10	LWD	10							C	MF	1	N
G	C	100	L	R	H	37	20	5	1	B	20	LWD	10							C	MF	1	N
C	G	175	L	R	H	72	46	9	1	LWD	30	C	5							C	MF	1	N
G	C	100	L	R	H	43	18	4		LWD	5	C	2							C	MF	1	N
G	C	100	L	R	H	11	4			SWD	10	C	10							C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

15	MIDDLEFORK	1	1	11	628015	5572215	850	G	1	25	0.08	1.25	0.65	21	16.5			

Comments :

clearcut to lub bank

G	C	100	L	R	H	4	1			C	2									C	MF	1	N

Level 1 - Habitat Summary Diagnosis Report

Form Number: 105	Forest District:	INVERMERE			
	Watershed Name:	WHITE RIVER			
	Watershed Code:	349-666200-00000-00000-0000-0000-000-000-000-000-000-000			
Survey Date:	6/21/2003	Weather:	Cloudy	Survey Crew:	SC/KM
Discharge:	7.14	(cubic meters per second)			

Subsampling Fractions:

Riffles	1 in 1	Pools	1 in 1	Glides	1 in 1	Cascades	1 in 1	Other	1 in 1

NTS Maps (1:50,000) :	082J06	BGGS Maps (1:20,000) :	082J034
			082J035
			082J024
			082J025

Detail No	Sub Basin Name	Reach No	Section No	UTM			Distance (m)	Habitat Unit		Length (m)	Grad (%)	Mean Depth		Mean Width		Pools Only			
				Zone	Easting	Northing		Type	Cat			Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth	Crest (m)	Residual	Pool Type
1	MIDDLEFORK	2	2	11	627143	5575721	0	P	3	20	0	1.6	1.02	23.9	23.6	1.15	0.21	0.94	S
							Comments : Textremely stable channel; old growth riparian												
2	MIDDLEFORK	2	2				0	G	1	40	0.193	1.05	0.5	23.9	23.6				
							Comments : redds												
3	MIDDLEFORK	2	2	11	627185	5575689	40	R	1	58	0.317	0.98	0.4	25.7	25				
							Comments : redds												
4	MIDDLEFORK	2	2				98	P	1	98	0.086	1.8	1.22	23.6	13.3	1.3	0.37	0.93	S
							Comments : Both sidechannels connect downstream 200 m and re-enter downstream of site												

Form Number:
105

Bed Material Type						Total LWD Tally	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Riparian Vegetation			Barriers
Dom.	Sub-Dom.	D90 (mm)	Compaction	SG Type	SG Amt		10 - 20cm	20 - 50cm	>50c	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type	Structure	Canopy Closure	
G	C	40	L	R	H	3	3			C	15	LWD	15	SC	G	650				C	MF	3	N
G	S	40	L	R	H	34	26	6		C	10	LWD	10							C	MF	3	N
G	S	40	L	R	H	28	20	6	2	C	5	LWD	10							C	MF	3	N
G	S	40	L	R	H	56	33	20	3	C	10	LWD	30	SC	G	400				C	MF	3	N

Level 1 - Habitat Summary Diagnosis Report

5	MIDDLEFORK	2	2				196	R	1	94	0.447	1.35	0.6	29	14			

Comments :

redds

6	MIDDLFEFORK	2	2				220	P	3	20	0.1	1.75	1.17	23	13.3	1.6	0.64	0.96	S

Comments :

7	MIDDLEFORK	2	2				254	P	3	31	0.1	1.68	1.25	26	23	1.34	0.7	0.64	S

Comments :

8	MIDDLEFORK	2	2				290	P	1	34	0.1	1.98	1.35	22.3	10.5	1.5	0.87	0.63	S

Comments :

9	MIDDLEFORK	2	2				324	R	1	11	0.682	1.48	0.87	23	10.5			

Comments :

10	MIDDLEFORK	2	2				335	P	1	75	0.161	2.35	1.58	32	20	1.9	0.4	1.5	S

Comments :

X-channel jam

11	MIDDLEFORK	2	2				410	R	1	12	0.417	1.18	0.59	28.5	15.6			

Comments :

12	MIDDLEFORK	2	2	11	627349	5575454	422	P	1	48	0	2.5	1.65	19	10	2.05	0.3	1.75	S

Comments :

13	MIDDLEFORK	2	2				470	G	1	16	0.075	1.2	0.62	22.3	22			

Comments :

redds

14	MIDDLEFORK	2	2				486	R	1	10	1.29	1.42	0.75	21	14			

Comments :

G	S	40	L	R	H	87	48	32	3	LWD	15	C	10							C	MF	3	N
G	S	40	L	R	H	4	3	1		C	15	LWD	2							C	MF	3	N
S	G	20	L	R	L	33	20	11	1	LWD	60	C	5							C	MF	3	N
G	S	40	L	R	L	17	12	5		LWD	40	C	10				DW			C	MF	2	N
G	S	40	L	R	H	22	13	8		LWD	20	C	10				DW			C	MF	2	N
S	G	20	L	R	L	84	41	35	4	LWD	80	C	5							C	MF	2	N
G	S	40	L	R	H	10	8	1		LWD	2									C	MF	1	N
S	G	20	L	R	L	20	12	5		LWD	10	C	5							C	MF	1	N
G	S	40	L	R	H	2	2			LWD	2	C	2							C	MF	2	N
G	S	40	L	R	H	11	10	1		LWD	2	C	5							C	MF	3	N

Level 1 - Habitat Summary Diagnosis Report

15	MIDDLEFORK	2	2	11	627338	5575353	496	P	1	94	0.063	2	1.3	18.5	10.5	2	0.3	1.7	S

Comments :

S	G	20	L	R	L	41	28	10		LWD	10	C	10							C	MF	3	N

Level 1 - Habitat Summary Diagnosis Report

Form Number:	106
Forest District:	INVERMERE
Watershed Name:	BLACKFOOT CREEK
Watershed Code:	349-666200-40200-00000-0000-0000-000-000-000-000-000-000
Survey Date:	9/30/2003
Weather:	sunny and clear
Survey Crew:	SC/KM
Discharge:	0.41 (cubic meters per second)

Subsampling Fractions:

Riffles	Pools	Glides	Cascades	Other
1 in 1	1 in 1	1 in 1	1 in 1	1 in 1

NTS Maps (1:50,000) :	082J03
BGGS Maps (1:20,000) :	082J014
	082J004

Detail No	Sub Basin Name	Reach No	Section No	UTM			Distance (m)	Habitat Unit		Length (m)	Grad (%)	Mean Depth		Mean Width		Pools Only			
				Zone	Easting	Northing		Type	Cat			Bankfull (m)	Water (m)	Bankfull (m)	Wetted (m)	Max Depth	Crest (m)	Residual	Pool Type
1	BLACKFOOT	1	1	11	618390	5546472	10	R	1	54	1.889	0.75	0.33	14.7	8.5				
							Comments : Highly disturbed. Harvested to streambank. Upper valley burnec to this point. Banks unravelling and bedload increse.												
2	BLACKFOOT	1	1				45	P	3	3	0.05	0.75	0.33	14.7	8.5	0.6	0.3	0.3	S
							Comments :												
3	BLACKFOOT	1	1				64	P	1	13	0.354	1.05	0.63	14	6	0.65	0.3	0.35	S
							Comments :												
4	BLACKFOOT	1	1				78	R	1	38	2.16	0.7	0.32	13	6.2				
							Comments :												
5	BLACKFOOT	1	1				115	G	1	35	0.277	0.6	0.21	10	8				
							Comments : 16 redds												

Form Number:
106

Bed Material Type						Total	Functional LWD			Cover				Offchannel Habitat			Disturbance Indicators			Riparian Vegetation			Barriers
Dom.	Sub-Dom.	D90 (mm)	Compaction	SG Type	SG Amt	LWD Tally	10 - 20cm	20 - 50cm	>50c	Cover Type 1	%	Cover Type 2	%	Type	Access	Length (m)	1	2	3	Type	Structure	Canopy Closure	
C	B	260	M	R	L	6				B	10	SWD	2	SL	P	50	EB	FP	SC	C	PS	1	N
C	G	200	M	R	L	0				C	10	SWD	10				EB	DW	BC	C	PS	1	N
C	G	200	M	R	L	28	16	6	3	LWD	50	B	10				EB	DW	FP	C	PS	1	N
C	G	250	M	R	L	6	1	1	1	B	10	OV	2				EB	DW	SC	C	INIT	1	N
G	C	100	M	R	H	2				OV	2						DW	EB	FP	C	INIT	1	N

Level 1 - Habitat Summary Diagnosis Report

6	BLACKFOOT	1	1	11	618364	5546626	150	R	1	168	1.475	0.7	0.3	17.3	16.2			

Comments :

1 redd

7	BLACKFOOT	1	1				239	P	3	3	0.3	0.9	0.46	14	10	0.6	0.3	0.3	S

Comments :

1 redd

8	BLACKFOOT	1	1				318	P	1	12	0.128	1.3	0.84	15	9	0.9	0.3	0.6	S

Comments :

9	BLACKFOOT	1	1				330	R	1	8	3.025	0.7	0.33	12	6			

Comments :

10	BLACKFOOT	1	1				338	P	1	16	0.1	1.35	0.94	9	6.6	1	0.29	0.71	S

Comments :

11	BLACKFOOT	1	1				354	G	1	6	0	0.9	0.47	14	8			

Comments :

redd

12	BLACKFOOT	1	1				360	R	1	38	2.083	0.65	0.27	10	6			

Comments :

13	BLACKFOOT	1	1				398	P	1	16	0.007	1	0.66	20	9	0.8	0.27	0.53	D

Comments :

14	BLACKFOOT	1	1				414	R	1	9	3.122	0.65	0.24	20	6			

Comments :

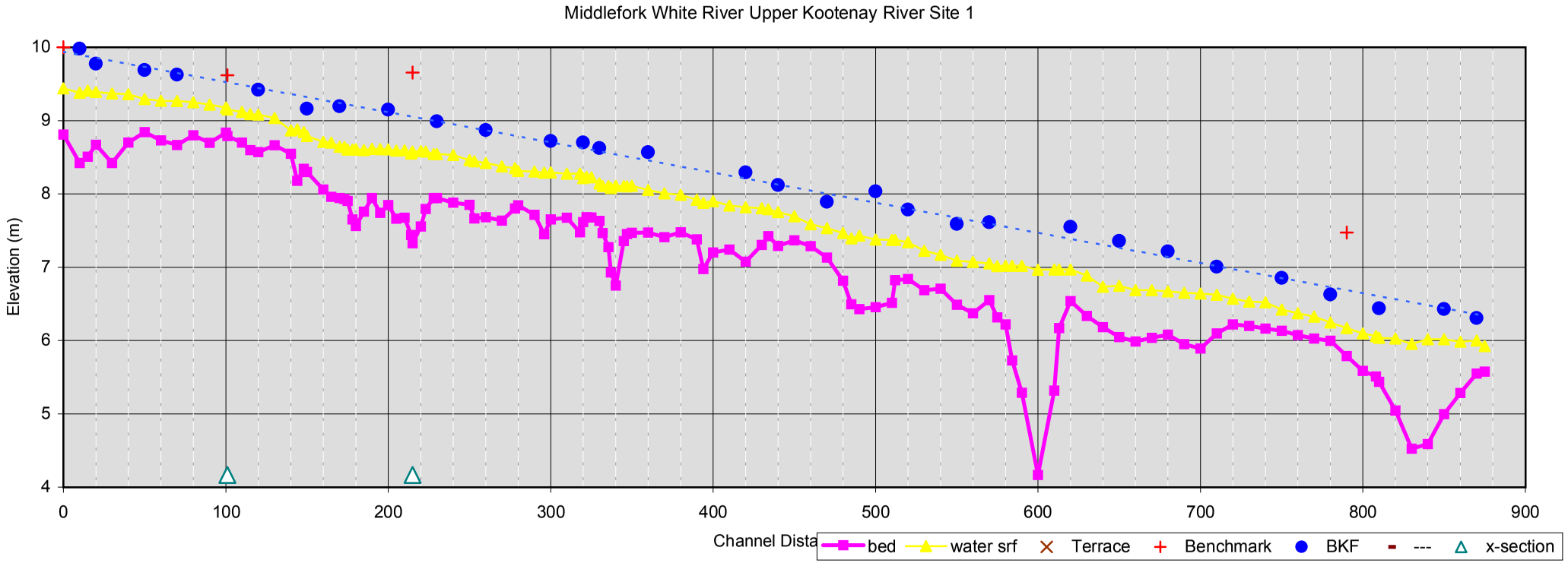
15	BLACKFOOT	1	1				423	P	1	13	0.53	1.15	0.71	16	9	0.85	0.2	0.65	D

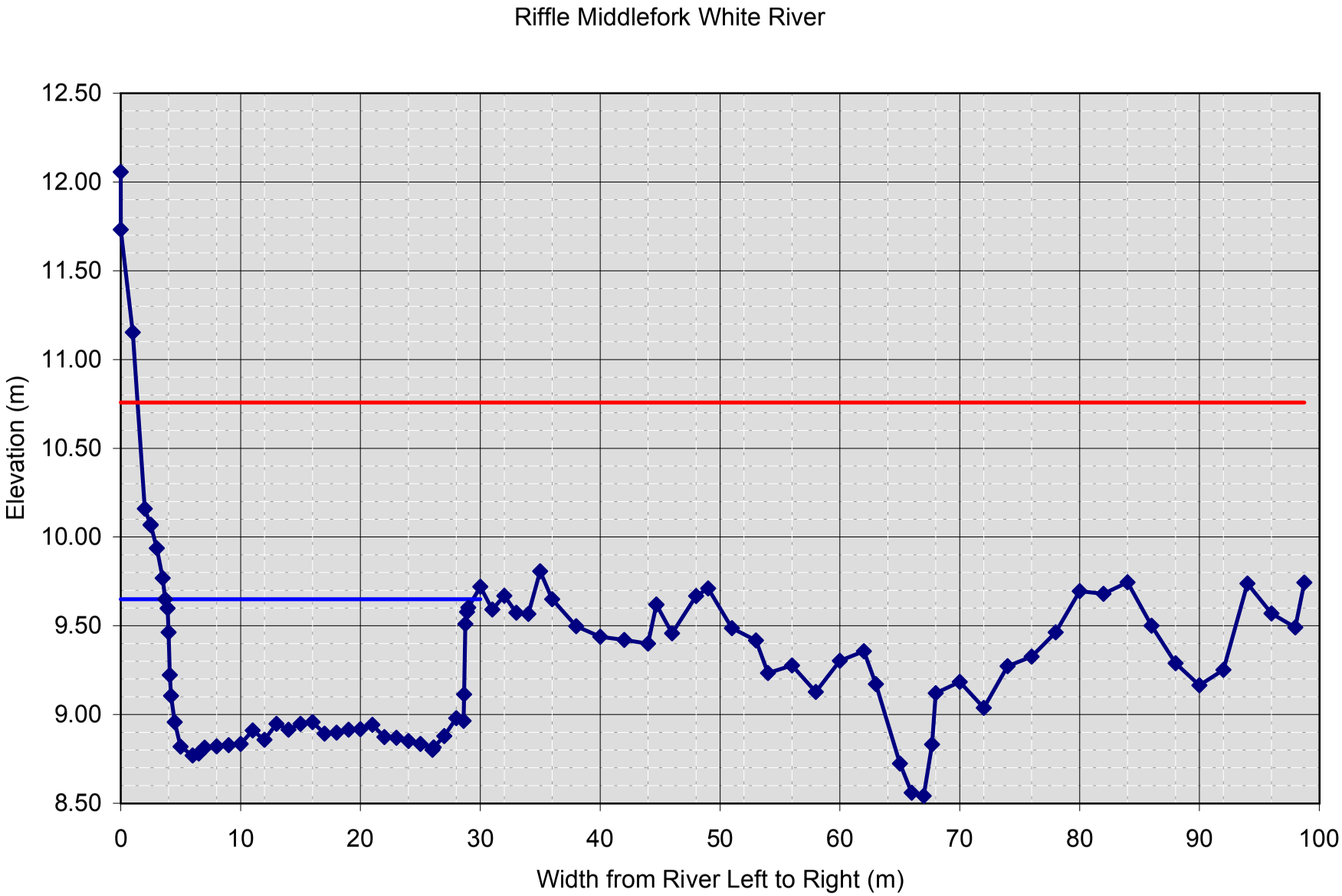
Comments :

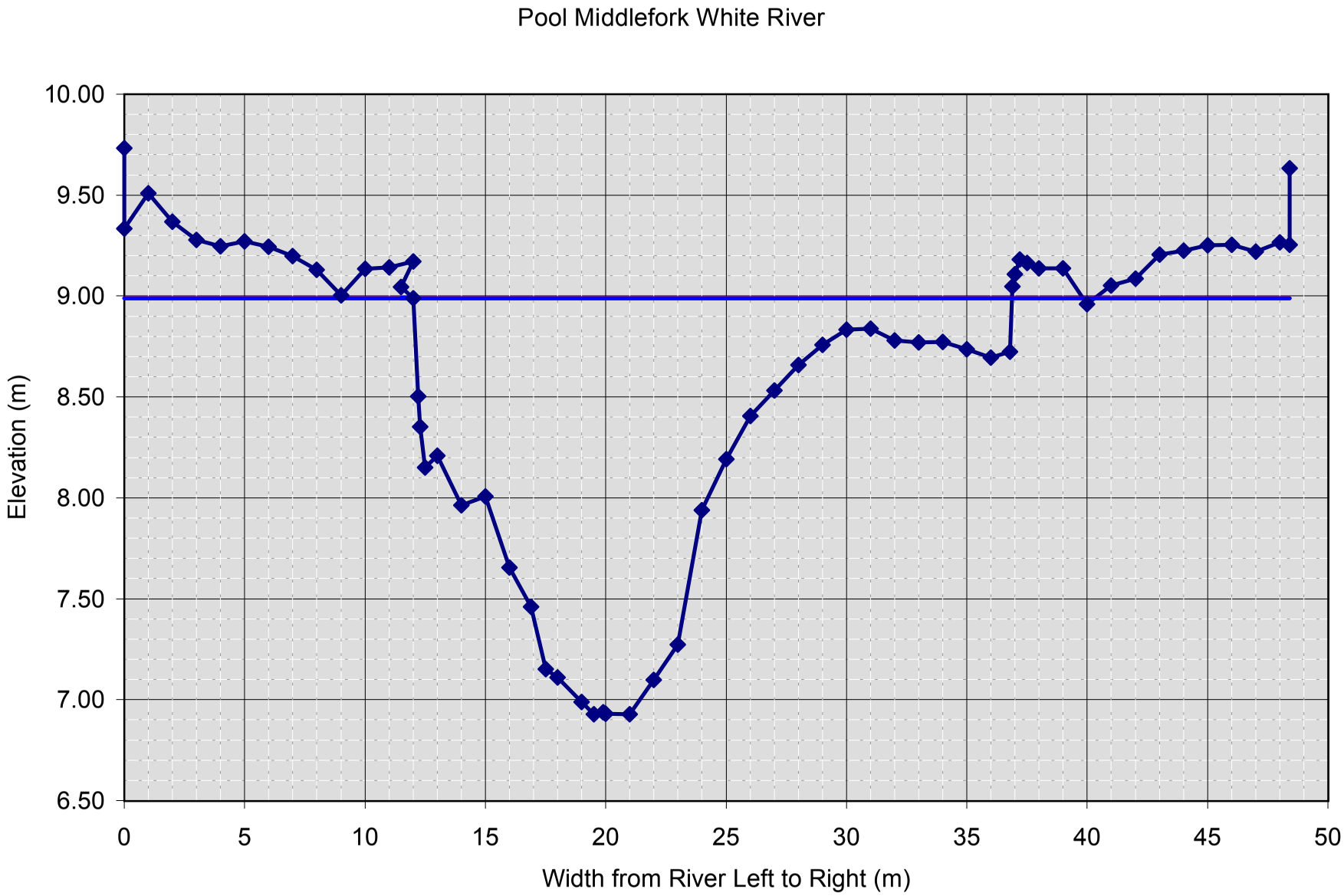
C	G	250	M	R	L	30	13	7		LWD	5	B	10				BC	LR	EB	C	PS	1	N
G	C	100	M	R	H	4	2			LWD	20	SWD	30				DW	SC	FP	C	PS	1	N
G	C	100	M	R	H	18	8	1		LWD	40	C	10				FP	DW	WG	C	INIT	1	N
C	G	200	M	R	L	4	1			B	15						DW	WG	MB	C	PS	1	N
C	G	200	M	R	L	54	9	1		C	10	LWD	10				WG	DW	FP	C	PS	1	N
G	C	100	M	R	H	7	3			LWD	2						DW	FP	EB	C	PS	1	N
C	G	250	M	R	L	13	6			LWD	2	B	5				WG	MB	DW	C	MF	1	N
G	C	100	M	R	H	21	6	3	1	LWD	30	OV	5				WG	MB	DW	C	MF	1	N
C	G	200	M	R	L	12	4	2		LWD	5	B	5	SC	G	10	MB	DW	WG	C	MF	1	N
C	G	250	M	R	L	4		1		LWD	30	C	10				MB	DW	WG	C	MF	1	N

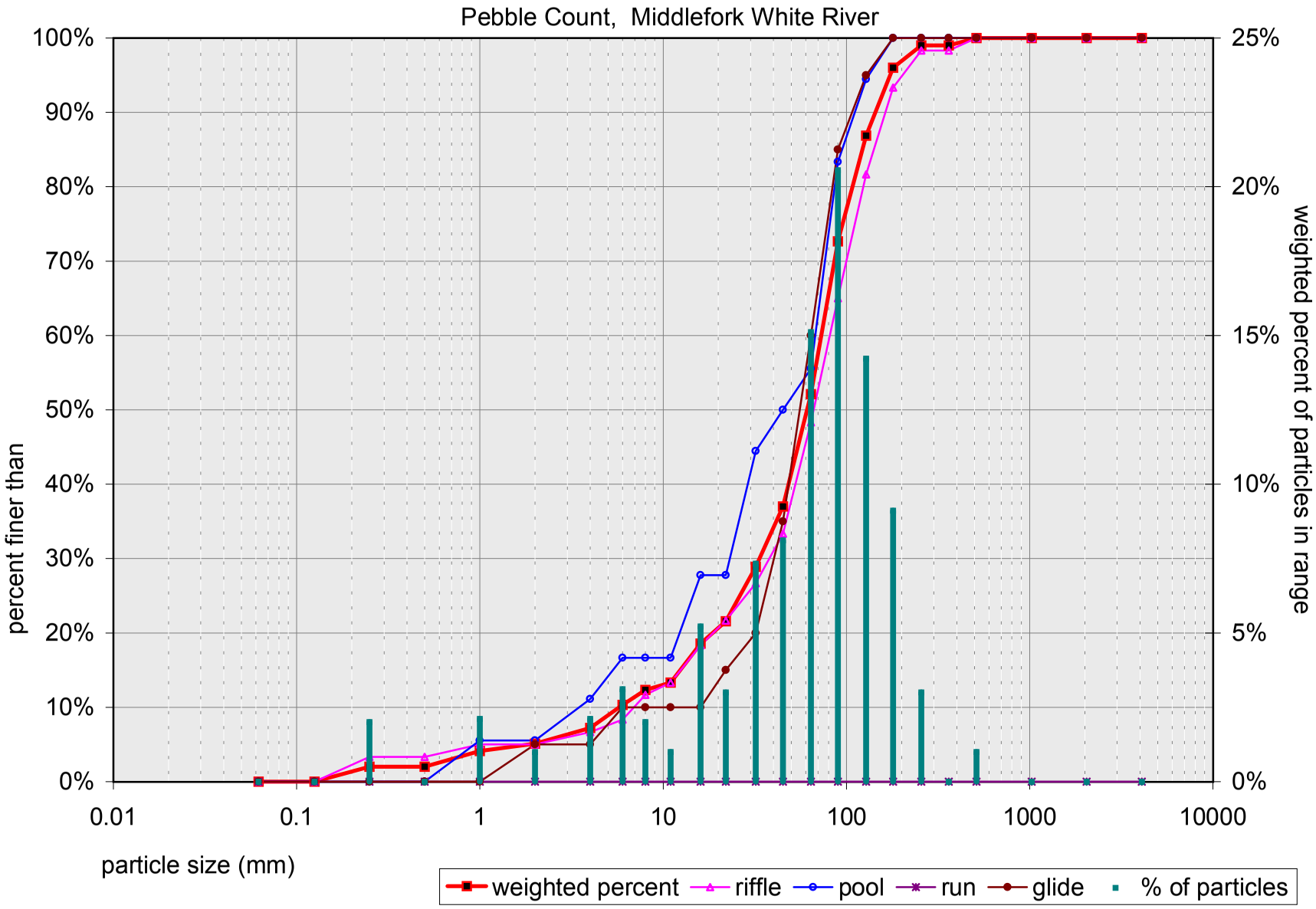
Appendix D

FHAP Channel Survey Data


Middlefork White River Upper Kootenay River Site 1
Elevation (m)
10
9
8
7
6
5
4
0
100
200
300
400
500
600
700
800
900
Channel Dista
bed
water srf
Terrace
Benchmark
BKF
---
x-section


Riffle Middlefork White River
12.50
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
Elevation (m)
0
10
20
30
40
50
60
70
80
90
100
Width from River Left to Right (m)


Pool Middlefork White River
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
Elevation (m)
0
5
10
15
20
25
30
35
40
45
50
Width from River Left to Right (m)


Pebble Count, Middlefork White River
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
percent finer than
25%
20%
15%
10%
5%
0%
weighted percent of particles in range
0.01
0.1
1
10
100
1000
10000
particle size (mm)
weighted percent
riffle
pool
run
glide
% of particles

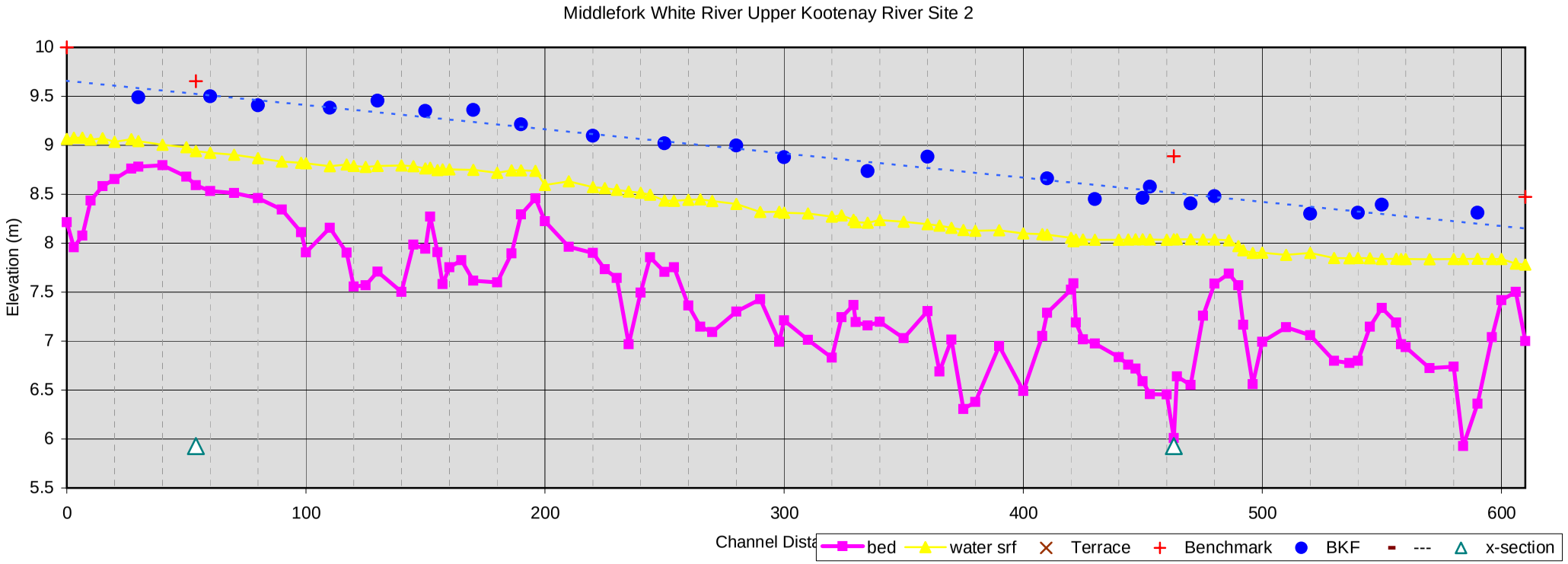
Differential Level Survey Loop

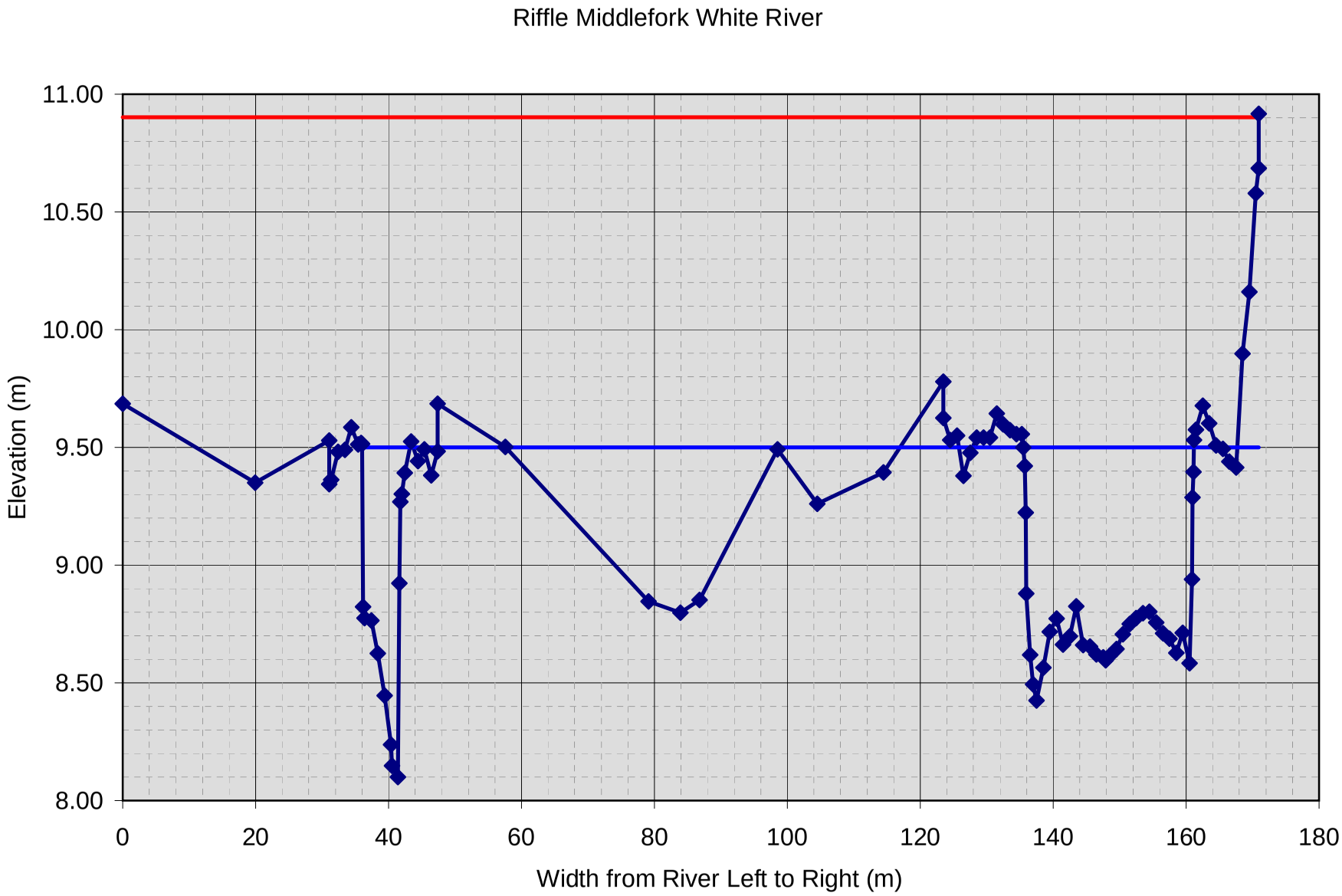
Middle Fork White River - Site 1 Sept 23,2003
KM/SC

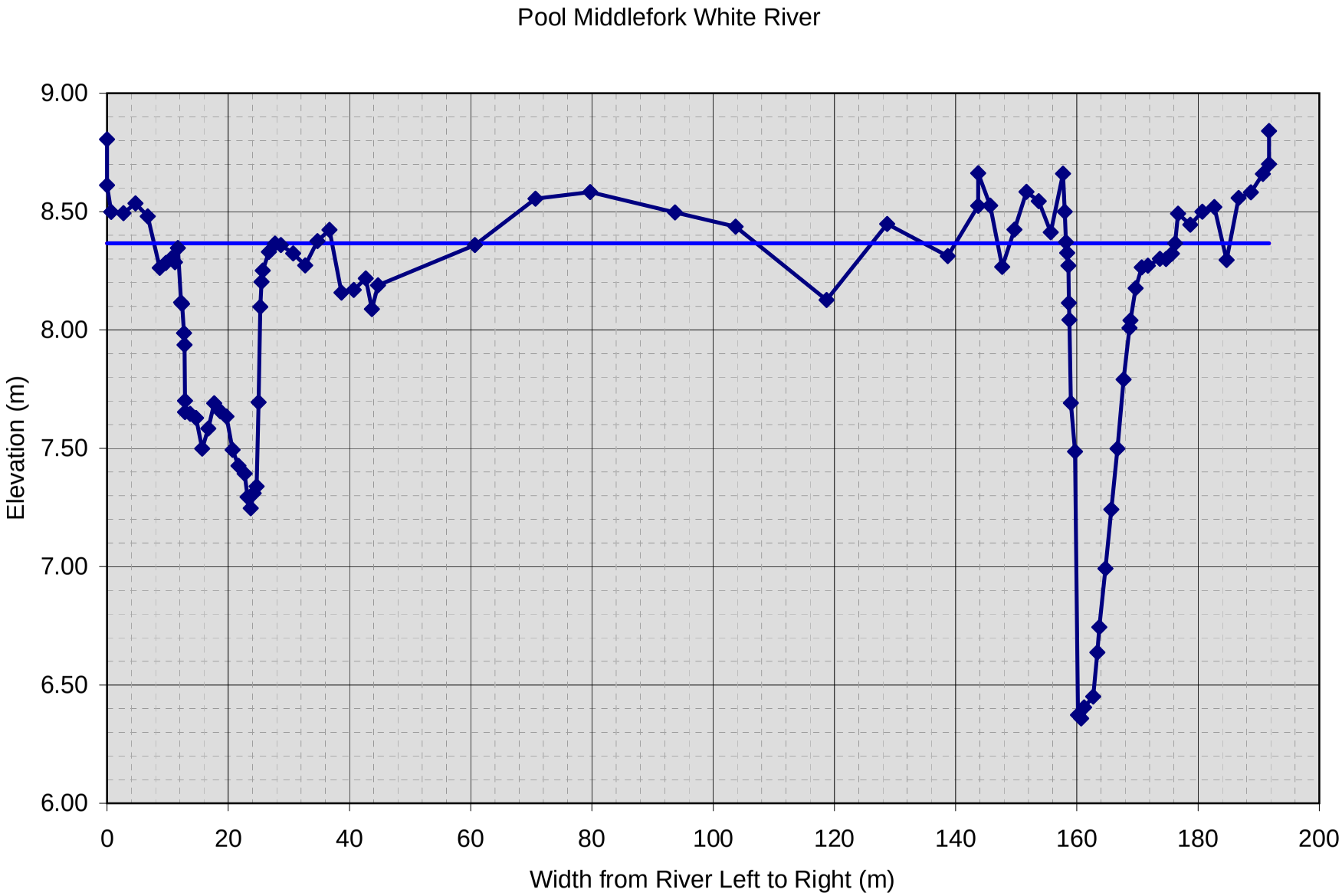
Station	Back Site	Ht. Of Inst	Fore Site	Elevation	Comments
BM1	1.110	11.110		10.000	arbitrary elevation
BM2	0.658	10.277	1.491	9.619	
BM3		10.277	0.621	9.656	
RP1	1.146	9.817	1.606	8.671	
RP2			1.380	8.437	23-Sep
RP1	1.127	9.798		8.671	24-Sep
RP2	0.647	9.084	1.361	8.437	
RP3	0.915	8.619	1.380	7.704	
RP4	0.664	7.732	1.551	7.068	
BM4	0.260	7.732	0.260	7.472	
RP4	1.545	8.619	0.658	7.074	
RP3	1.426	9.135	0.910	7.709	
RP2	1.340	9.780	0.695	8.440	
RP1	1.519	1.019	1.108	8.672	
BM2	1.610	11.229	0.572	9.619	
BM1			1.123	10.001	

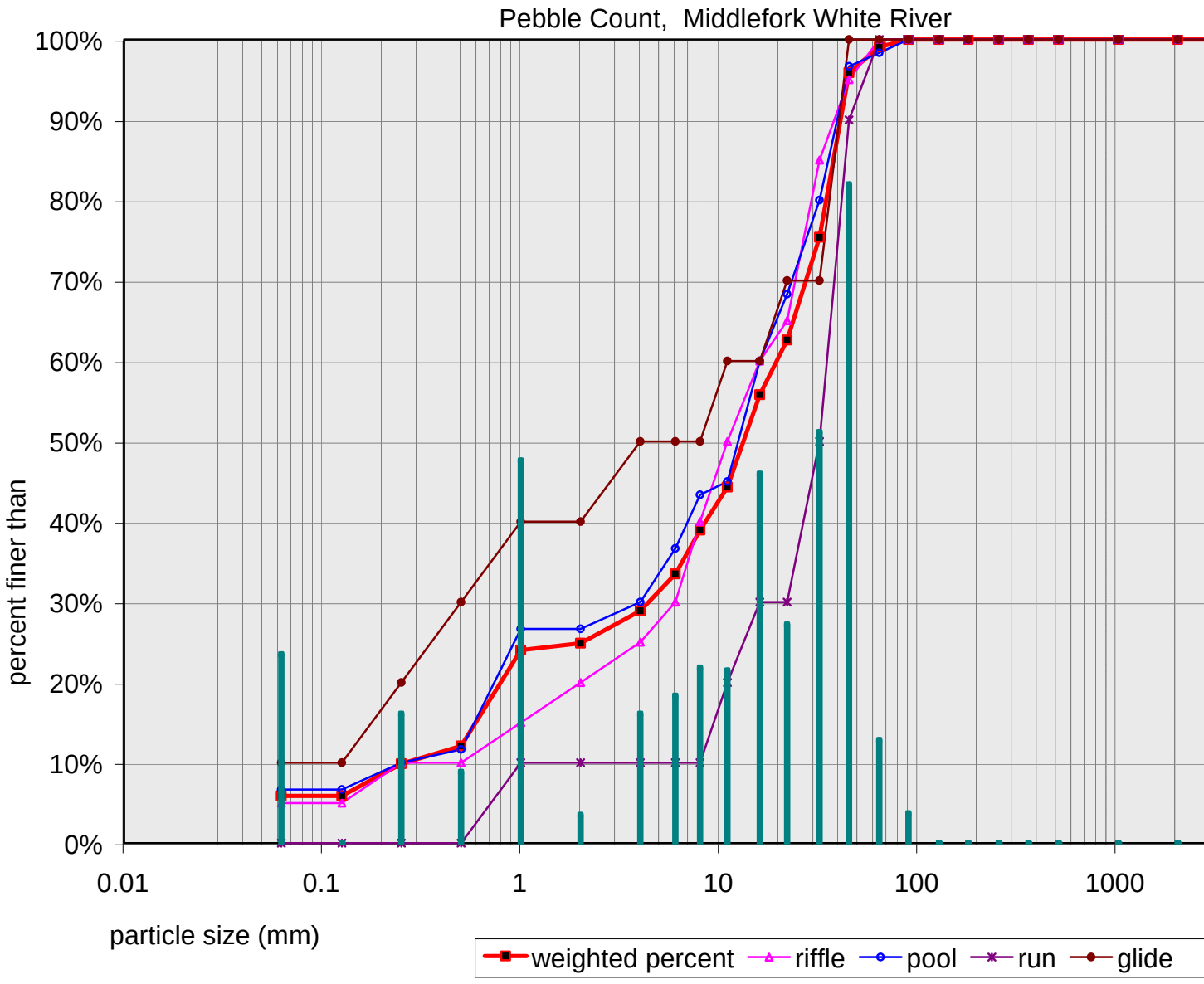
All benchmarks are lagbolts in base of riparian spruce trees
see map for locations

BM1	11.627908E.5572751N
BM2	11.627943E.5572693N @ 107.5 m
BM3	11.627929E.5572568N @ 220 m
BM4	11.627993E.5572274N


Middlefork White River Upper Kootenay River Site 2
Elevation (m)
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
0
100
200
300
400
500
600
Channel Dista
bed
water srf
Terrace
Benchmark
BKF
---
x-section


Riffle Middlefork White River
11.00
10.50
10.00
9.50
9.00
8.50
8.00
Elevation (m)
0
20
40
60
80
100
120
140
160
180
Width from River Left to Right (m)


Pool Middlefork White River
9.00
8.50
8.00
7.50
7.00
6.50
6.00
Elevation (m)
0
20
40
60
80
100
120
140
160
180
200
Width from River Left to Right (m)


Pebble Count, Middlefork White River
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
percent finer than
0.01
0.1
1
10
100
1000
particle size (mm)
weighted percent
riffle
pool
run
glide

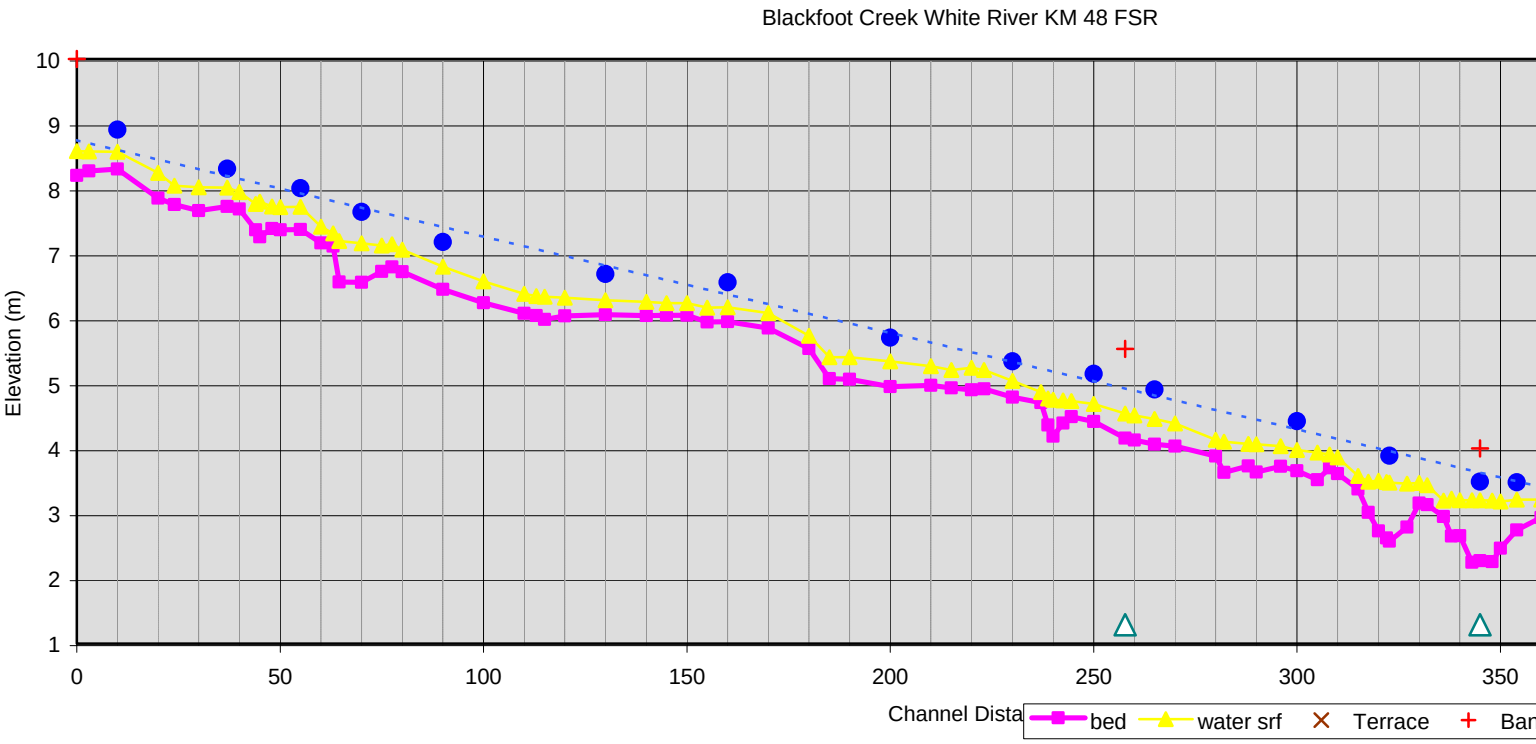
Differential Level Survey Loop

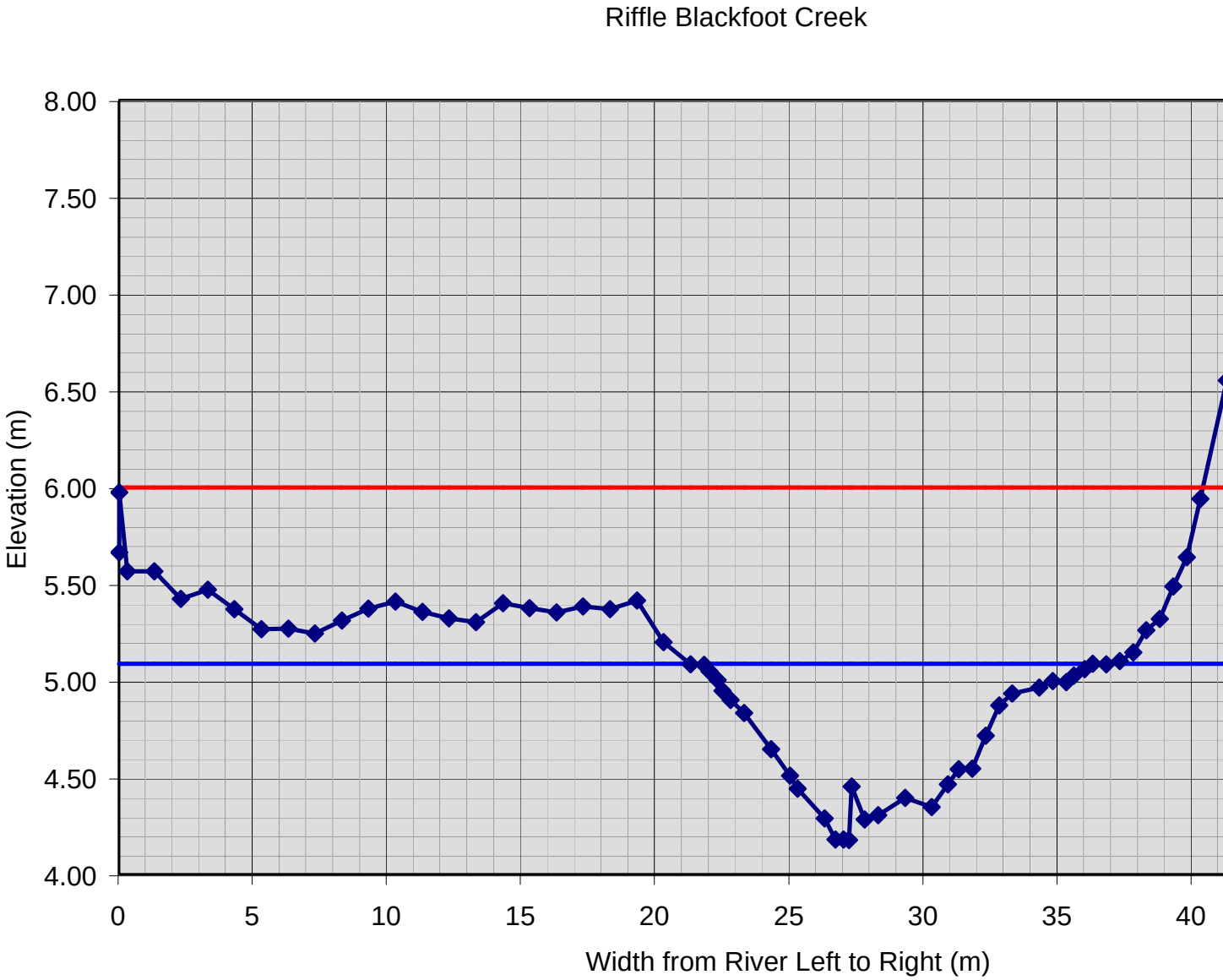
Middle Fork White River - Site 2 Sept 18,2003
KM/SC

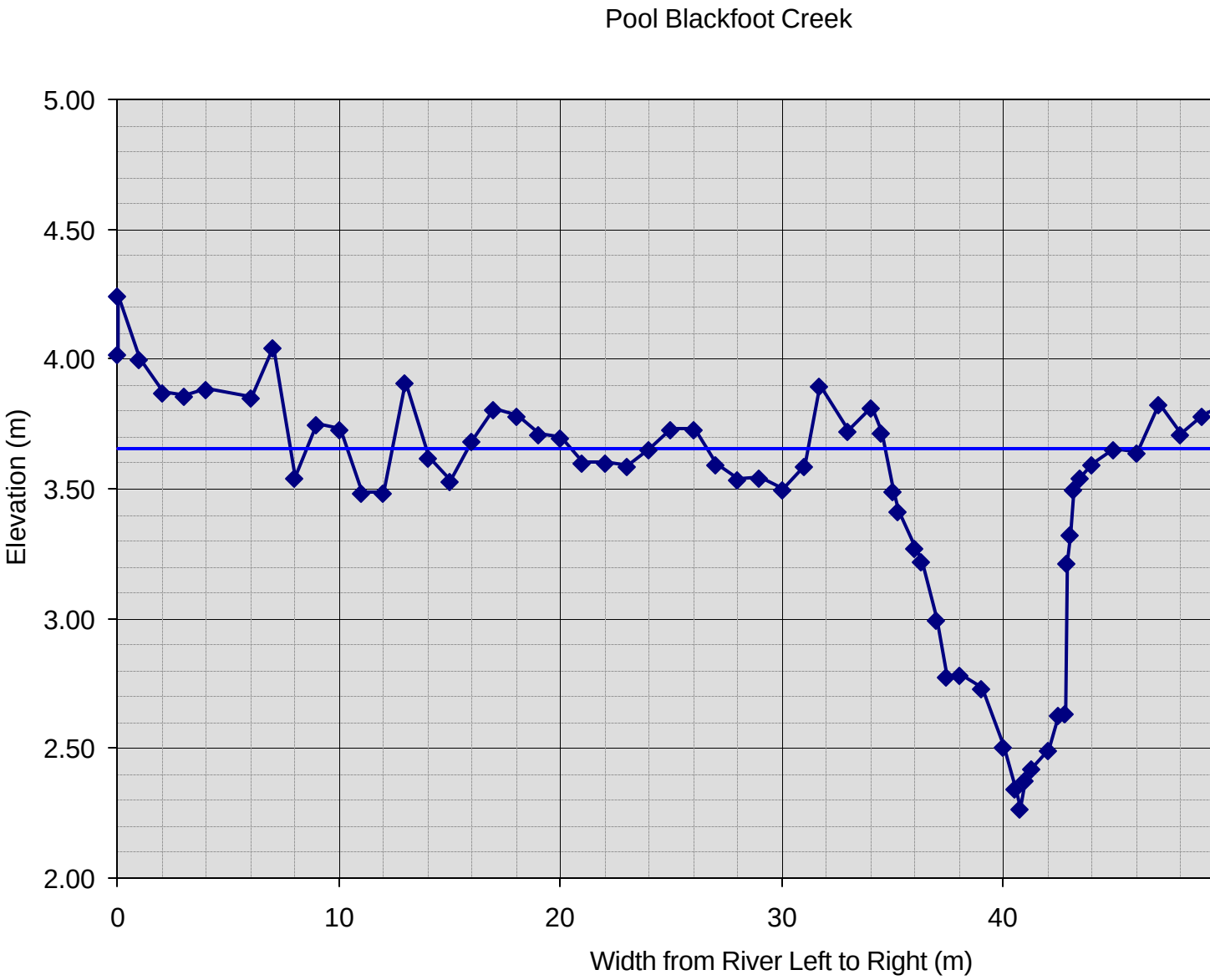
Station	Back Site	Ht. Of Inst	Fore Site	Elevation	Comments
BM1	0.679	10.679		10.000	arbitrary elevation
BM2			1.024	9.655	
RP1	0.939	10.417	1.201	9.478	
RP2	1.399	10.183	1.633	8.784	
RP3	0.909	10.055	1.037	9.146	
BM3			1.167	8.888	
RP4	0.983	9.486	1.552	8.503	
BM4		9.486	1.014	8.472	
BM4	1.014	9.486		8.472	
RP4	1.556	10.059	0.983	8.503	
RP3	1.038	10.185	0.912	9.147	
RP2	1.664	10.449	1.400	8.785	
RP1	1.230	10.709	0.970	9.479	
BM1			0.710	9.999	

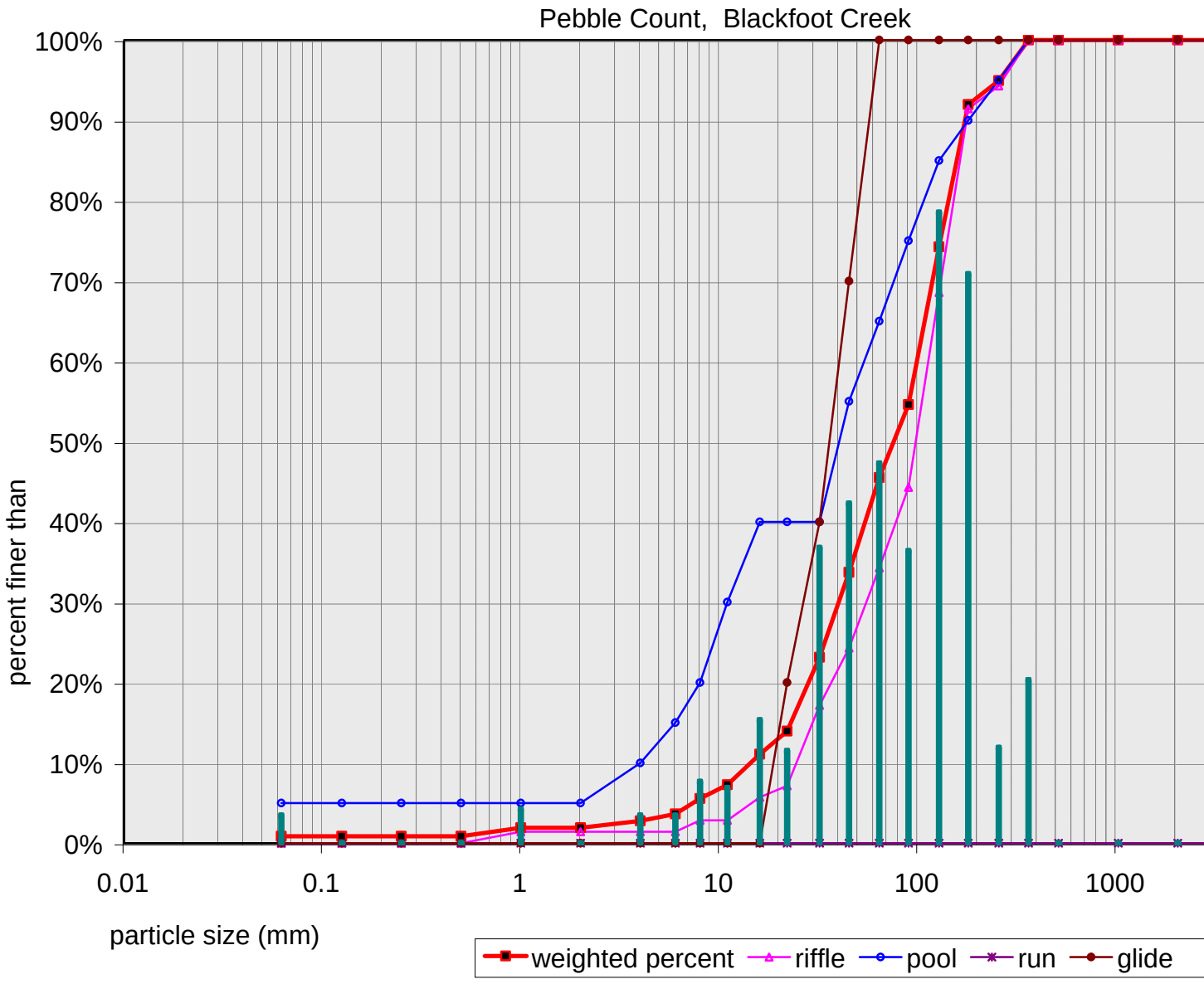
All benchmarks are lagbolts in base of riparian spruce trees
see map for locations

BM1 UTM 11.627143E.5575721N @ 0+27m
BM2 UTM 11.627160E.5575681N @ 0+55m
BM3 UTM 11.627334E.5575464N @ 0+468m
BM4 UTM 11.627333E.5575338N @ 0+610m


Blackfoot Creek White River KM 48 FSR
Elevation (m)
10
9
8
7
6
5
4
3
2
1
0
50
100
150
200
250
300
350
Channel Dista
bed
water srf
Terrace
Ban


Riffle Blackfoot Creek
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
Elevation (m)
0
5
10
15
20
25
30
35
40
Width from River Left to Right (m)


Pool Blackfoot Creek
5.00
4.50
4.00
3.50
3.00
2.50
2.00
Elevation (m)
0
10
20
30
40
Width from River Left to Right (m)


Pebble Count, Blackfoot Creek
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
percent finer than
0.01
0.1
1
10
100
1000
particle size (mm)
weighted percent
riffle
pool
run
glide

Blackfoot Creek
Site 3 - White River
29 September, 2003
Scott Cope/Kerry morris

Field (Arbitrary) Elevations (m)

Station	Backsight	Height of Instrument	Foresight	Elevation	Comment
BM1	0.510	10.510		10.000	
RP1	1.130	8.444	3.196	7.314	
RP2	0.461	6.621	2.284	6.160	
RP3	1.118	5.981	1.758	4.863	
BM3			1.975	4.006	
RP4	1.300	4.527	2.754	3.227	
BM4			1.819	2.708	
BM4	1.840	4.548			
RP4	2.948	6.174	1.322	3.226	
BM3			2.170	4.004	
RP3	1.783	6.647	1.310	4.864	
BM2			1.111	5.536	
RP2	2.320	8.481	0.486	6.161	
RP1	3.205	10.518	1.168	7.313	
BM1			0.519	9.999	

Benchmarks are lagbolts in the base of riparian trees - see map for locations.

Appendix E

Stream Channel Classification (Level II) Form

Stream Channel Classification (Level II) Form

Stream Name:	Middlefork White River	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	202.2 Km^2		
Location:	Site 1 - KM 61.5 Axle FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.627940E.5572700N (riffle) 11.627946E.5572643N (pool)	
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	23-Sep-03

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	26.40	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section (d_{bkf} = A/W_{bkf}).	0.79	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	20.80	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	33.51	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.20	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	190	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	7.20	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	61	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0040	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.49	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**C3(1)**	

Stream Channel Classification (Level II) Form

Stream Name:	Middlefork White River	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	192 Km^2		
Location:	Site 2 - km 64.5 Middlefork FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.627185E.5575689N (riffle) 11.627349E.5575454N (pool)	
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	18-Sep-03

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	31.00	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A/W_{bkf}$).	0.63	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	19.40	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	49.54	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	1.20	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	297	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	9.58	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	13	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0021	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.41	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**C4**	

Stream Channel Classification (Level II) Form

Stream Name:	Blackfoot Creek	Watershed Name:	Kootenay River
Drainage Area (u/s of site)	84.8 Km^2		
Location:	Site 3 - km 48 Blackfoot FSR		
Cross-Section Monuments (UTM - Zone.Easting.Northing)		11.618364E.5546626N (riffle) 11.618329E.5546725N (pool)	
Crew/Company:	SC/KM - Westslope Fisheries Ltd.	Date:	29-September, 2003

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankful stage elevation, in riffle section.	15.60	m
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel x-section, at bankfull stage elevation, in a riffle section (d_{bkf} = A/W_{bkf}).	0.42	m
Bankfull X-Sectional AREA (A_{bkf}) AREA of the stream channel x-section, at bankfull stage elevation, in riffle section.	6.60	m^2
Width/Depth Ratio (W_{bkf}/d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in riffle section.	36.87	
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel x-section, or distance between the bankfull stage and thalweg elevations, in a riffle section.	0.90	m
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined, in a riffle section	147	m
Entrenchment Ratio (ER) The ratio of flood-prone area divided by bankfull channel WIDTH, in a riffle section (W_{fpa}/W_{bkf})	9.44	
Channel Materials (Particle Size Index) D_{50} The D50 particle size index represents the mean diameter of channel materials (n=100), as sampled from the channel surface, between the left and right bankfull stage elevations.	76	mm
Water Surface SLOPE (S) Channel SLOPE = "rise over run" for a reach approximately 20-30 bankfull channel widths in length, with the "top of riffle to riffle" water surface slope representing the gradient at bankfull stage.	0.0152	m/m
Channel SINUOSITY (K) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from the ratio of valley slope divided by channel slope (VS/S).	1.17	
Stream Type Refer to Page 5-6, Figure 5-3 in Rosgen's 1996, "Applied River Morphology" book.	**D3**	

Appendix F

Reference Reach Data Summary Form

Reference Reach Data Summary Form

Stream Name: Middlefork White River

Location: Site 1 - km 61.5 Axle FSR

Channel DIMENSION
Data from Riffle & Pool X-sectional surveys

Bankfull Pool Width (W_{bkfp})	25.40	m	Bankfull Riffle Width (W_{bkf})			25.70	m
Bankfull Pool Depth (d_{bkfp})	0.89	m	Bankfull Riffle Depth (d_{bkf})			0.74	m
X-Section Data							
Bankfull Pool XS Area (A_{bkfp})	22.60	m^2	Bankfull Riffle XS Area (A_{bkf})			18.90	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	2.10	m	Max. Bankfull Riffle Depth (d_{mbkf})			1.10	m
X-Section Data							
Max. Bankfull Pool Depth (d_{mbkfp})	1.50 (Min.)	m	2.50 (Max.)	m	1.88 (Mean)		m
Long. Profile Data							
Ratio: Bankfull Pool Width/Bankfull Riffle Width:						0.99	(W_{bkfp})/(W_{bkf})
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:						1.21	(d_{bkfp})/(d_{bkf})
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:						1.20	(A_{bkfp})/(A_{bkf})
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:			2.04 (Min.)		3.40 (Max.)	2.56 Mean	(d_{mbkfp})/(d_{bkf})
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:	1.10	m				1.00	Bh_{low}/(d_{mbkf})
(Lowest Bank Height - measured from thalwag to top of lowest bank, in a riffle section)							
Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)						1.42	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)						23	m^3/s

Channel PATTERN

Meander Length (L_m)	134 (Min.)	m	302 (Max.)	m	235 (Mean)		m
Radius of Curvature (R_c)	59 (Min.)	m	134 (Max.)	m	81 (Mean)		m
Belt Width (W_{BLT})	84 (Min.)	m	151 (Max.)	m	120 (Mean)		m
Ratio: Meander Length/Bankfull Riffle Width			5.21 (Min.)		11.75 (Max.)	9.14 (Mean)	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width			2.30 (Min.)		5.21 (Max.)	3.15 (Mean)	(R_c/W_{bkf})
Meander Width Ratio (MWR):			3.27 (Min.)		5.88 (Max.)	4.67 (Mean)	(W_{BLT}/W_{bkf})

Channel PROFILE
Data from Longitundinal Profile Survey

Valley Slope (VS)	0.0056	m/m	Water Surface SLOPE (S)			0.0040	m/m
Riffle Surface Slope (S_r)	0.0032 (Min.)	m/m	0.0074 (Max.)	m/m	0.0045 (Mean)		m/m
Pool Surface Slope (S_p)	0.0000 (Min.)	m/m	0.0013 (Max.)	m/m	0.0006 (Mean)		m/m
Glide Surface Slope (S_g)	0.0000 (Min.)	m/m	0.0027 (Max.)	m/m	0.0009 (Mean)		m/m
Run Surface Slope (S_{run})	0.0043 (Min.)	m/m	0.0097 (Max.)	m/m	0.0079 (Mean)		m/m
Bankfull Max. Riffle Depth (d_{rmax})	0.90 (Min.)		1.20 (Max.)	m	1.10 (Mean)		m
Bankfull Glide Depth (d_g)	1.20 (Min.)	m	1.25 (Max.)	m	1.23 (Mean)		m
Bankfull Run Depth (d_{run})	0.90 (Min.)	m	1.20 (Max.)	m	1.06 (Mean)		m
Pool Length (P_{length})	9.50 (Min.)	m	48.00 (Max.)	m	32.00 (Mean)		m
Pool to Pool Spacing ($P_{spacing}$)	90.00 (Min.)	m	235.00 (Max.)	m	159.00 (Mean)		m
Ratio: Riffle Surface Slope/Water Surface Slope			0.80 (Min.)		1.83 (Max.)	1.12 (Mean)	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope			0.00 (Min.)		0.31 (Max.)	0.15 (Mean)	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope			0.00 (Min.)		0.66 (Max.)	0.22 (Mean)	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope			1.07 (Min.)		2.42 (Max.)	1.95 (Mean)	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth			1.22 (Min.)		1.63 (Max.)	1.50 (Mean)	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth			1.63 (Min.)		1.70 (Max.)	1.67 (Mean)	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth			1.22 (Min.)		1.63 (Max.)	1.44 (Mean)	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width			0.37 (Min.)		1.87 (Max.)	1.25 (Mean)	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width			3.50 (Min.)		9.14 (Max.)	6.19 (Mean)	$P_{spacing}$/W_{bkf}

Channel MATERIALS

% Sand & <	0	D_{16}		13	mm
% Gravel	46	D_{35}		41	mm
% Cobble	46	D_{50}		61	mm
% Boulder	1	D_{84}	138 (riffle)	119 (cummulative)	mm
% Bedrock	2	D_{95}		173	mm

Reference Reach Data Summary Form

Stream Name: Middlefork White River

Location: Site 2 - km 64.5 Middlefork FSR

Channel DIMENSION
Data from Riffle & Pool X-sectional Surveys

Bankfull Pool Width (W_{bkfp})	33.00	m	Bankfull Riffle Width (W_{bkf})			31.00	m
Bankfull Pool Depth (d_{bkfp})	0.74	m	Bankfull Riffle Depth (d_{bkf})			0.63	m
X-Section Data							
Bankfull Pool XS Area (A_{bkfp})	24.50	m^2	Bankfull Riffle XS Area (A_{bkf})			19.40	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	2.00	m	Max. Bankfull Riffle Depth (d_{mbkf})			1.20	m
X-Section Data							
Max. Bankfull Pool Depth (d_{mbkfp})	1.60	m	2.50	m	2.04	m	
Long. Profile Data	(Min.)		(Max.)		(Mean)		
Ratio: Bankfull Pool Width/Bankfull Riffle Width:						1.06	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:						1.19	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:						1.26	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:				2.56 (Min.)	3.99 (Max.)	3.26 Mean	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth:				1.20 m		1.00	$Bh_{low}/(d_{mbkf})$
(Lowest Bank Height - measured from thalwag to top of lowest bank, in a riffle section)							
Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)						1.16	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)						22	m^3/s

Channel PATTERN

Meander Length (L_m)	142		300		211	m	
Radius of Curvature (R_c)	50		150		96	m	
Belt Width (W_{BLT})	67 (Min.)		117 (Max.)		90 (Mean)	m	
Ratio: Meander Length/Bankfull Riffle Width				4.58 (Min.)	9.68 (Max.)	6.81 (Mean)	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width				1.61 (Min.)	4.84 (Max.)	3.10 (Mean)	(R_c/W_{bkf})
Meander Width Ratio (MWR):				2.16 (Min.)	3.77 (Max.)	2.90 (Mean)	(W_{BLT}/W_{bkf})

Channel PROFILE
Data from Longitudinal Profile Survey

Valley Slope (VS)	0.0027	m/m	Water Surface SLOPE (S)			0.0021	m/m
Riffle Surface Slope (S_r)	0.0042 (Min.)	m/m	0.0042 (Max.)	m/m	0.0042 (Mean)	m/m	
Pool Surface Slope (S_p)	0.0000 (Min.)	m/m	0.0016 (Max.)	m/m	0.0008 (Mean)	m/m	
Glide Surface Slope (S_g)	0.0003 (Min.)	m/m	0.0008 (Max.)	m/m	0.0006 (Mean)	m/m	
Run Surface Slope (S_{run})	0.0027 (Min.)	m/m	0.0129 (Max.)	m/m	0.0062 (Mean)	m/m	
Bankfull Max. Riffle Depth (d_{rmax})	1.03		1.20		1.14	m	
Bankfull Glide Depth (d_g)	1.05		1.30		1.18	m	
Bankfull Run Depth (d_{run})	1.35 (Min.)		1.48 (Max.)		1.41 (Mean)	m	
Pool Length (P_{length})	34.00 (Min.)	m	94.00 (Max.)	m	68.00 (Mean)	m	
Pool to Pool Spacing ($P_{spacing}$)	45.00 (Min.)	m	192.00 (Max.)	m	99.50 (Mean)	m	
Ratio: Riffle Surface Slope/Water Surface Slope				2.00 (Min.)	2.00 (Max.)	2.00 (Mean)	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope				0.00 (Min.)	0.77 (Max.)	0.39 (Mean)	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope				0.14 (Min.)	0.36 (Max.)	0.28 (Mean)	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope				1.28 (Min.)	6.20 (Max.)	2.98 (Mean)	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth				1.65 (Min.)	1.92 (Max.)	1.82 (Mean)	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth				1.68 (Min.)	2.08 (Max.)	1.89 (Mean)	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth				2.16 (Min.)	2.36 (Max.)	2.25 (Mean)	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width				1.10 (Min.)	3.03 (Max.)	2.19 (Mean)	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width				1.45 (Min.)	6.19 (Max.)	3.21 (Mean)	$P_{spacing}/W_{bkf}$

Channel MATERIALS

% Sand & <	25	D_{16}		1	mm
% Gravel	74	D_{35}		7	mm
% Cobble	1	D_{50}		13	mm
% Boulder	0	D_{84}	33	37	mm
% Bedrock	0	D_{95}		44	mm

Reference Reach Data Summary Form

Stream Name: Blackfoot Creek

Location: Site 3 - km 48 Blackfoot FSR

Channel DIMENSION
Data from Riffle & Pool X-sectional surveys

Bankfull Pool Width (W_{bkfp})	16.90	m	Bankfull Riffle Width (W_{bkf})	15.60	m
Bankfull Pool Depth (d_{bkfp})	0.41	m	Bankfull Riffle Depth (d_{bkf})	0.42	m
X-Section Data					
Bankfull Pool XS Area (A_{bkfp})	7.00	m^2	Bankfull Riffle XS Area (A_{bkf})	6.60	m^2
Max. Bankfull Pool Depth (d_{mbkfp})	1.30	m	Max. Bankfull Riffle Depth (d_{mbkf})	0.90	m
X-Section Data					
Max. Bankfull Pool Depth (d_{mbkfp})	1.00 (Min.)	m	1.35 (Max.)	1.17 (Mean)	m
Long. Profile Data					
Ratio: Bankfull Pool Width/Bankfull Riffle Width:				1.08	$(W_{bkfp})/(W_{bkf})$
Ratio: Bankfull Pool Depth/Bankfull Riffle Depth:				0.98	$(d_{bkfp})/(d_{bkf})$
Ratio: Bankfull Pool XS Area/Bankfull Riffle XS Area:				1.06	$(A_{bkfp})/(A_{bkf})$
Ratio: Bankfull Max. Pool Depth/Bankfull Riffle Depth:	2.36 (Min.)		3.19 (Max.)	2.77 Mean	$(d_{mbkfp})/(d_{bkf})$
Ratio: Lowest Bank Height/Max. Bankfull Riffle Depth: (Lowest Bank Height - measured from thalwag to top of lowest bank, in a riffle section)	0.90	m		1.00	$Bh_{low}/(d_{mbkf})$
Streamflow: Estimated Mean Velocity (u_{bkf}) @ Bankfull Stage (riffle section)				1.46	m/s
Streamflow: Estimated Discharge (Q_{bkf}) @ Bankfull Stage (riffle section)				10	m^3/s

Channel PATTERN

Meander Length (L_m)	169 (Min.)	225 (Max.)	200 (Mean)	m
Radius of Curvature (R_c)	56	75	65	m
Belt Width (W_{BLT})	75 (Min.)	115 (Max.)	102 (Mean)	m
Ratio: Meander Length/Bankfull Riffle Width	10.83 (Min.)	14.42 (Max.)	12.82 (Mean)	(L_m/W_{bkf})
Ratio: Radius of Curvature/Bankfull Riffle Width	3.59 (Min.)	4.81 (Max.)	4.17 (Mean)	(R_c/W_{bkf})
Meander Width Ratio (MWR):	4.81 (Min.)	7.37 (Max.)	6.54 (Mean)	(W_{BLT}/W_{bkf})

Channel PROFILE
Data from Longitudinal Profile Survey

Valley Slope (VS)	0.0172	m/m	Water Surface SLOPE (S)	0.0152	m/m
Riffle Surface Slope (S_r)	0.0077 (Min.)	m/m	0.0216 (Max.)	0.0165 (Mean)	m/m
Pool Surface Slope (S_p)	0.0007 (Min.)	m/m	0.0065 (Max.)	0.0030 (Mean)	m/m
Glide Surface Slope (S_g)	0.0000 (Min.)	m/m	0.0053 (Max.)	0.0018 (Mean)	m/m
Run Surface Slope (S_{run})	0.0303 (Min.)	m/m	0.0556 (Max.)	0.0068 (Mean)	m/m
Bankfull Max. Riffle Depth (d_{rmax})	0.65		0.90	0.07	m
Bankfull Glide Depth (d_g)	0.60		0.90	0.75	m
Bankfull Run Depth (d_{run})	0.70 (Min.)		1.00 (Max.)	0.85 (Mean)	m
Pool Length (P_{length})	10.00		30.00	17.20	m
Pool to Pool Spacing ($P_{spacing}$)	20.50 (Min.)		132.50 (Max.)	60.00 (Mean)	m
Ratio: Riffle Surface Slope/Water Surface Slope	0.50 (Min.)		1.42 (Max.)	1.09 (Mean)	(S_r/S)
Ratio: Pool Surface Slope/Water Surface Slope	0.05 (Min.)		0.43 (Max.)	0.20 (Mean)	(S_p/S)
Ratio: Glide Surface Slope/Water Surface Slope	0.00 (Min.)		0.35 (Max.)	0.12 (Mean)	(S_g/S)
Ratio: Run Surface Slope/Water Surface Slope	1.99 (Min.)		3.66 (Max.)	0.45 (Mean)	(S_{run}/S)
Ratio: Bankfull Max. Rifffle Depth/Bankfull Riffle Depth	1.54 (Min.)		2.13 (Max.)	0.17 (Mean)	d_{rmax}/d_{bkf}
Ratio: Bankfull Glide Depth/Bankfull Riffle Depth	1.42 (Min.)		2.13 (Max.)	1.77 (Mean)	d_g/d_{bkf}
Ratio: Bankfull Run Depth/Bankfull Riffle Depth	1.65 (Min.)		2.36 (Max.)	2.01 (Mean)	d_g/d_{bkf}
Ratio: Pool Length/Bankfull Riffle Width	0.64 (Min.)		1.92 (Max.)	1.10 (Mean)	P_{length}/W_{bkf}
Ratio: Pool to Pool Spacing/Bankfull Riffle Width	1.31 (Min.)		8.49 (Max.)	3.85 (Mean)	$P_{spacing}/W_{bkf}$

Channel MATERIALS

% Sand & <	2	D_{16}	24	mm
% Gravel	44	D_{35}	47	mm
% Cobble	49	D_{50}	76	mm
% Boulder	5	D_{84}	169 (riffle) / 154 (cummulative)	mm
% Bedrock	0	D_{95}	257	mm

Appendix G

Velocity Calculations

Velocity Calculations

Date	23-Sep-03	**Gage Number**	08NF003
Stream	Middlefork White River -Site 1 (61.5 km)		

Input Variables			Output Variables		
Bankfull Cross Sectional Area (A_{BKF})	18.90	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	0.74	m
Bankfull Width (W_{BKF})	25.7	m	Wetted Perimeter (WP) (~($2*D_{BKF}$)+W_{BKF})	27.2	m
D84 (Riffle)	138	mm	D84 (mm/1000)	0.14	m
Bankfull Slope (S)	0.00402	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.70	m
Gravitational Acceleration (g)	9.81	m/s^2	R/D84 (use D84 in meters)	5.04	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	7.0	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.035	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.42	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
u/u*=2.83+5.7logR/D84

u*: $u^*=(gRS)^{0.5}$	0.17	m/s
Velocity: u=u*(2.83+5.7logR/D84)	1.13	m/s

Mannings n by Stream Type

Stream Type

Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.034	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.46	m/s

Continuity Equation

Q_{BKF} (cfs) from stream gage calibration	69.5	cms
Velocity (u=Q/A or from stream gage hydraulic geometry)	3.68	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = ($R^{1/6}$ x 0.0926)/(1.16 + 2log(R/D_{84})) 0.0340

Velocity Calculations

Date	18-Sep-03	**Gage Number**	08NF003
Stream	Middlefork White River -Site 2 (64.5 km)		

Input Variables			Output Variables		
Bankfull Cross Sectional Area (A_{BKF})	19.40	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	0.63	m
Bankfull Width (W_{BKF})	31.0	m	Wetted Perimeter (WP) (~($2*D_{BKF}$)+W_{BKF})	32.3	m
D84 (Riffle)	33	mm	D84 (mm/1000)	0.03	m
Bankfull Slope (S)	0.00208	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.60	m
Gravitational Acceleration (g)	9.81	m/s^2	R/D84 (use D84 in meters)	18.23	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	10.0	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.028	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.16	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
$u/u^*=2.83+5.7\log R/D84$

u^*: $u^*=(gRS)^{0.5}$	0.11	m/s
Velocity: $u=u^*(2.83+5.7\log R/D84)$	1.11	m/s

Mannings n by Stream Type

Stream Type

Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.0231	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.41	m/s

Continuity Equation

Q_{BKF} (cfs) from stream gage calibration	52.6	cms
Velocity (u=Q/A or from stream gage hydraulic geometry)	2.71	m/s

Limerinos Equation (1970)

Manning's "n" using: $"n" = (R^{1/6} \times 0.0926)/(1.16 + 2\log(R/D_{84}))$ 0.0231

Velocity Calculations

Date	29-Sep-03		**Gage Number**		
Stream	Blackfoot Creek - Site 3 (km 48)				

Input Variables			Output Variables		
Bankfull Cross Sectional Area (A_{BKF})	6.60	m^2	Bankfull Mean Depth D_{BKF} = (A_{BKF}/W_{BKF})	0.42	m
Bankfull Width (W_{BKF})	15.6	m	Wetted Perimeter (WP) (~($2*D_{BKF}$)+W_{BKF})	16.4	m
D84 (Riffle)	169	mm	D84 (mm/1000)	0.17	m
Bankfull Slope (S)	0.01518	m/m	Hydraulic Radius (R) (A_{BKF}/WP)	0.40	m
Gravitational Acceleration (g)	9.81	m/s^2	R/D84 (use D84 in meters)	2.37	m/m

R/D84, u/u*, Mannings n

u/u* (using R/D84: see Reference Reach Field Book: p188, River Field Book:p233)	5.1	m/s/ m/s
Mannings n: (Reference Reach Field Book: p189, River Field Book:p236)	0.046	
Velocity: from Manning's equation: $u=R^{2/3}S^{1/2}/n$	1.46	m/s

Resistance as a function of Relative Roughness (Leopold 1994)
$u/u^*=2.83+5.7\log R/D84$

u*: $u^*=(gRS)^{0.5}$	0.24	m/s
Velocity: $u=u^*(2.83+5.7\log R/D84)$	1.22	m/s

Mannings n by Stream Type

Stream Type		
Mannings n: (Reference Reach Field Book: p187, River Field Book:p237)	0.0416	m1/6
Velocity: from Manning's equation $u=R^{2/3}S^{1/2}/n$	1.61	m/s

Continuity Equation

Q_{BKF} (cfs) from stream gage calibration	50.5	cms
Velocity (u=Q/A or from stream gage hydraulic geometry)	7.65	m/s

Limerinos Equation (1970)

Manning's "n" using: "n" = ($R^{1/6}$ x 0.0926)/(1.16 + 2log(R/D_{84}))	0.0416